An optical barcode forming method for optical discs, a marking forming apparatus, and a method of manufacturing an optical disk

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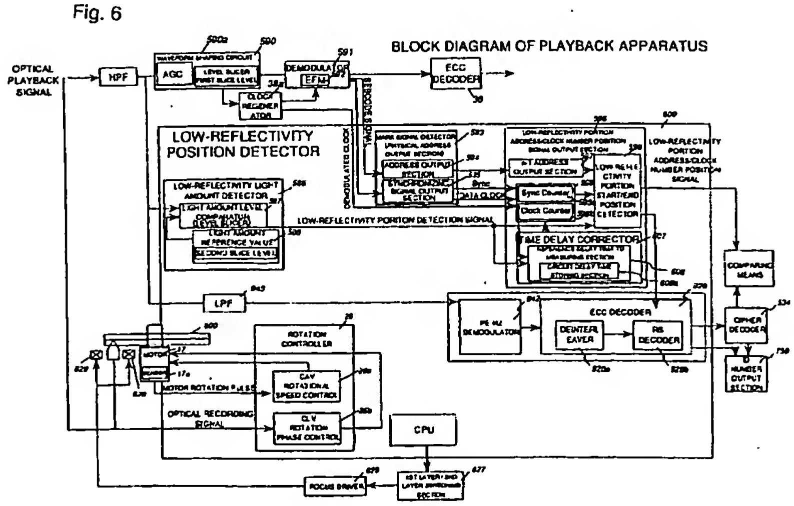
(54) An optical disk reproduction apparatus

(57) An optical disk reproducing apparatus for reproducing information from an optical disk on which a first signal is recorded by pit pattern with a first recording clock and a second signal is recorded with overlapping state on said first signal with a second recording clock having a frequency of more than 14 times of the first clock, comprises high frequency suppressing means for suppressing a signal having a frequency which is higher than a predetermined frequency, said high frequency suppressing means being provided with a reproduced information and being adapted to suppress said first signal to extract the second signal at its output.

Fig. 6



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Description

TECHNICAL FIELD

[0001] The present invention relates to an optical disk reproduction apparatus.

BACKGROUND ART

[0002] In the manufacturing process of optical disks, it has been commonly practiced to record a serial number, lot number, etc. on each optical disk in the form of a barcode.

[0003] Since such information cannot be written to a pit information area of the optical disk, it has been practiced to write the barcoded information to a non-information area, or unused space, on the optical disk.

[0004] When reproducing (playing back) such an optical disk, the pit information is read by an optical pickup; to read the barcoded information such as a serial number, etc. recorded in the non-information area, however, a separate reading device has been used.

[0005] In the above prior art optical disk, since information carrying a serial number and the like is not recorded in a pit area but recorded in a non-information area, as described above, a separate reading device has had to be provided in addition to the usual optical pickup, the resulting problem being increased complexity of the playback apparatus construction.

DISCLOSURE OF INVENTION

[0006] In view of the above problem with the prior art, it is an object of the present invention to provide an optical disk reproduction apparatus of reduced complexity.

[0007] The invention is an optical disk reproduction apparatus wherein recorded contents of a recording area, recorded by forming pits on an optical disk, are reproduced by using a rotational phase control for a motor, while recorded contents of a different recording area other than said recording area, recorded by selectively forming low-reflectivity portions on a reflective film in said different recording area, are roproduced by using rotational speed control for said motor, and

the recorded contents of said recording area and the recorded contents of said different recording area are both reproduced by using the same optical pickup.

[0008] The invention further is an optical disk reproduction apparatus wherein tracking control is not performed in said different recording area.

[0009] The invention also provides an optical disk reproduction apparatus wherein tracking control is, in effect, performed in said different recording area.

[0010] An embodiment of the invention is an optical disk reproduction apparatus wherein a rotational speed is the rotational speed that would be achieved in said different recording area if said rotational phase control were applied.

[0011] The invention further provides an optical disk reproduction apparatus wherein the rotational speed of said motor in said rotational speed control is maintained at a prescribed value based on a result obtained by measuring a minimum-length pit in said different recording area.

[0012] Another embodiment of the invention is an optical disk reproduction apparatus wherein said low-reflectivity portions are a barcode formed by selectively removing said reflective film.

[0013] The invention provides an optical disk reproduction apparatus whererein

said low-reflectivity portions are a barcode,said diffrent recording area is also such area to which contents are recorded with pits, and

when reproducing the recorded contents of said different recording area, a high-frequency-component signal generated during reproduction of said pits which are formend in said different recording area is reduced or eliminated by a low-pass filter, thereby making it possible to separate a signal which is re roduced from said barcode.

[0014] Another embodiment is an optical disk reproduction apparatus wherein

said low-reflectivity portions are a barcode, and

when reproducing the recorded contents of said different recording area, the width of a signal obtained by reading said barcode is increased to a prescribed width and then measured with sampling pulses from a control section.

[0015] The invention further provides an optical disk reproduction apparatus which is suitable to reproduce an optical disk which includes a control data area for holding therein physical feature information concerning said optical disk, and an identifier for indicating the presence or absence of said barcode is recorded in said control data area.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Figure 1 is a diagram showing a disk manufacturing process and a secondary recording process;

Figure 2(a) is a top plan view of a disk according to the embodiment, (b) is a top plan view of the disk (c) is a top plan view of the disk (d) is a transverse sectional view of the disk and (e) is a waveform diagram of a reproduced signal;

Figure 3 is a diagram showing a disk fabrication process and a secondary recording process (part 1);

Figure 4 is a diagram showing the disk fabrication process and the secondary recording process (part

2);

Figure 5(a) is a diagram showing part (b) of Figure 11 in further detail, (b) is a diagram showing an equivalent data structure for ECC encoding/decoding, (c) is a diagram showing a mathematical equation for EDC computation, and (d) is a diagram showing a mathematical equation for ECC computation;

Figure 6 is a block diagram of a low-reflectivity position detector;

Figure 7 is a diagram illustrating the principle of detecting address/clock positions of a low-reflectivity portion;

Figure 8 is a diagram showing the arrangement of stripes on a disk and the contents of control data;

Figure 9 is a flowchart illustrating how control mode is switched between CAV and CLV when playing back stripes;

Figure 10 is a diagram showing a stripe area and an address area on a disk;

Figure 11(a) is a diagram showing a data structure after ECC encoding, (b) is a diagram showing a data structure after ECC encoding (when n = 1), and (c) is a diagram showing an ECC error-correction capability;

Figure 12 is a diagram showing the data structure of a synchronization code;

Figure 13(a) is a diagram showing the configuration of an LPF, and (b) is a diagram showing a waveform filtered through the LPF;

Figure 14(a) is a diagram showing a reproduced signal waveform, and (b) is a diagram for explaining a dimensional accuracy of a stripe;

Figure 15 is a diagram showing a procedure for reading control data for playback;

Figure 16 is a diagram showing a procedure for playing back a PCA area in a tracking ON condition;

Figure 17 is a block diagram of a playback apparatus implementing rotational speed control;

Figure 18 is a block diagram of a playback apparatus implementing rotational speed control;

Figure 19 is a block diagram of a playback apparatus implementing rotational speed control.

[0017] We will first describe a general process flow from disk manufacturing to the completion of an optical disk by using the flowchart of Figure 1.

[0018] In this patent specification, laser trimming is also referred to as laser marking, while a nonreflective optical marking portion is simply referred to as the barcode, stripe, marking, or optical marking or, sometimes, as the physical ID unique to a disk.

[0019] First, the software company performs software authoring in software production process 820. The completed software is delivered from the software company to the disk manufacturing factory. In disk manufacturing process 816 at the disk manufacturing factory, the completed software is input in step 818a, a master disk is produced (step 818b), disks are pressed (steps 818e, 818g), reflective films are formed on the respective disks (steps 818f, 818h), the two disks are laminated together (step 818i), and a ROM disk such as a DVD or CD is completed (step 818m, etc.).

[0020] The thus completed disk 800 is delivered to the software maker or to a factory under control of the software maker, where, in secondary recording process 817, an anti-piracy marking 584, such the one shown in Figure 2, is formed (step 819a), and accurate position information of this mark is read by a measuring means (step 819b) to obtain the position information which serves as the physical feature information of the disk. This physical feature information of the disk is encrypted in step 819c. The encrypted information is converted to a PE-RZ-modulated signal which is then recorded in step 819d as a barcode signal on the disk by using a laser. The disk physical feature information may be combined together with software feature information for encryption in step 819c.

[0021] First, the disk fabrication process will be described. In the disk fabrication process 806 shown in Figure 3, first a transparent substrate 801 is pressed in step (1). In step (2), a metal such as aluminum or gold is sputtered to form a reflective layer 802. An adhesive layer 804 formed from an ultraviolet curing resin is applied by spin coating to a substrate 803 formed in a different processing step, and the substrate 803 is bonded to the transparent substrate 801 having the reflective layer 802, and they are rotated at high speed to make the bonding spacing uniform. By exposure to external ultraviolet radiation, the resin hardens, thus firmly bonding the two substrates together. In step (4), a printed layer 805 where a CD or DVD title is printed, is printed by screen printing or offset printing. Thus, in step (4), the ordinary laminated-type optical ROM disk is completed.

[0022] Next, the marking formation process will be described with reference to Figures 3 and 4. In Figure 3, a laser beam from a pulsed laser 813 such as a YAG laser is focused through a converging lens 814 onto the reflective layer 802, to form a nonreflective portion 815 as shown in step (6) in Figure 4. That is, a distinct waveform, such as the waveform (A) shown in step (7), is reproduced from the nonreflective portion 815 formed in step (6) in Figure 4. By slicing this waveform, a marking detection signal such as shown by waveform (B) is obtained, from which hierarchial marking position information comprising an address, such as shown in signal (d), and an address, a frame synchronizing signal number, and a reproduced clock count, such as shown in signal (e), can be measured.

[0023] At the rising edge of the thus obtained marking detection signal, a specific address (indicated by address n in Figure 4(d)) is read by the optical pickup from within the plurality of addresses shown in Figure 4(d). Figure 4(b) shows the physical location of the specific address in schematic form. On the other hand, Figure 4

(e) shows the logical structure of the data. As shown in Figure 4(e), there are m frame synchronization signals under address n, and k reproduced clock pulses under each frame synchronization signal. Therefore, the position of the marking measured by the optical pickup can be represented by address, frame synchronization signal number, and reproduced clock count.

[0024] Next, the process of reading the position of the marking will be described.

[0025] Figure 6 is a block diagram showing a low reflectivity light amount detector 586 for detecting the nonreflective optical marking portion, along with its adjacent circuitry, in an optical disk manufacturing process. Figure 7 is a diagram illustrating the principle of detecting address/clock positions of the low reflectivity portion. For convenience of explanation, the following description deals with the operating principle when a read operation is performed on a nonreflective portion formed on an optical disk constructed from a single disk. It will be recognized that the same operating principle also applies to an optical disk constructed from two disks laminated together.

[0026] As shown in Figure 6, the disk 800 is loaded into a marking reading apparatus equipped with a low reflectivity position detector 600 to read the marking, and in this case, since a signal waveform 823 due to the presence and absence of pits and a signal waveform 824 due to the presence of the nonreflective portion 584 are significantly different in signal level, they can be clearly distinguished using a simple circuit.

[0027] As shown in Figure 7(1), the start and end positions of the nonreflective portion 564 having the above waveform can be easily detected by the low reflectivity light amount detector 586 shown in the block diagram of Figure 6. Using the reproduced clock signal as the reference signal, position information is obtained in a low reflectivity position information output section 596. Figure 7(1) shows a cross-sectional view of the optical disk.

[0028] As shown in Figure 6, a comparator 587 in the low reflectivity light amount detector 586 detects the low reflectivity light portion by detecting an analog light reproduced signal having a lower signal level than a light amount reference value 588. During the detection period, a low reflectivity portion detection signal of the waveform shown in Figure 7(5) is output. The addresses and clock positions of the start position and end position of this signal are measured.

[0029] The reproduced light signal is waveshaped by a waveform shaping circuit 590 having an AGC 590a, for conversion into a digital signal. A clock regenerator 38a regenerates a clock signal from the waveshaped signal. An EFM demodulator 592 in a demodulating section 591 demodulates the signal, and an ECC corrects errors and outputs a digital signal. The EFM-demodulated signal is also fed to a physical address output section 593 where an address of MSF, from Q bits of a subcode in the case of a CD, is output from an address output section 594 and a synchronizing signal, such as a frame synchronizing signal, is output from a synchronizing signal output section 595. From the clock regenerator 38a, a demodulated clock is output.

[0030] In a low reflectivity portion address/clock signal position signal output section 596, a low reflectivity portion start/end position detector 599 accurately measures the start posistion and end position of the low reflectivity portion 584 by using an (n-1) address output section 597 and an address signal as well as a clock counter 598 and a synchronizing clock signal or the demodulated clock. This method will be described in detail by using the waveform diagrams shown in Figure 7. As shown in the cross-sectional view of the optical disk in Figure 7(1), the low reflectivity portion 584 of mark number 1 is formed partially. A reflection selope signal such as shown in Figure 7(3), is output, the signal level from the reflective portion being lower than the light amount reference value 588. This is detected by the light level comparator 587, and a low reflectivity light detection signal, such as shown in Figure 7(5), is output from the low reflectivity light amount detector 586. As shown by a reproduced digital signal in Figure 7(4), no digital signal is output from the mark region since it does not have a reflective layer.

[0031] Next, to obtain the start and end positions of the low reflectivity light detection signal, the demodulated clock or synchronizing clock shown in Figure 7(6) is used along with address information. First, a reference clock 605 at address n in Figure 7(7) is measured. When the address immediately preceding the address n is detected by the (n-1) address output section 597, it is found that the next sync 604 is a sync at address n. The number of clocks from the synch 604 to the reference clock 605, which is the start position of the low reflectivity light detection signal, is counted by the clock counter 598. This clock count is defined as a reference delay time TD which is measured by a reference delay time TD measuring section 608 for storage therein.

[0032] The circuit delay time varies with reproduction apparatus used for reading, which means that the reference delay time TD varies depending on the reproduction apparatus used. Therefore, using the TD, a time delay corrector 607 applies time correction, and the resulting effect is that the start clock count for the low reflectivity portion can be measured accurately if reproduction apparatus of different designs are used for reading. Next, by finding the clock count and the start and end addresses for the optical mark No. 1 in the next track, clock m+14 at address n+12 is obtained, as shown in Figure 7(8). Since TD = m + 2, the clock count is corrected to 12, but for convenience of explanation, n+14 is used. We will describe another method, which eliminates the effects of varying delay times without having to obtain the reference delay time TD in the reproduction apparatus used for reading. This method can check whether the disk is a legitimate disk or not by checking whether the positional relationship of mark 1

at address n in Figure 7(B) relative to another mark 2 matches or not. That is, TD is ignored as a variable, and the difference between the position, A1 = a1 + TD, of mark 1 measured and the position, A2 = a2 + TD, of mark 2 measured is obtained, which is given as A1 - A2 = a1 - a2. At the same time, it is checked whether this difference matches the difference, a1 - a2, between the position al of the decrypted mark 1 and the position information a2 of the mark 2, thereby judging whether the disk is a legitimate disk or not. The effect of this method is that the positions can be checked after compensating for variations of the reference delay time TD by using a simpler constitution.

[0033] We will next describe features of the optical disk format with a barcode formed in the above manner, tracking control methods, and rotational speed control methods that can be used when playing back the optical disk.

[0034] (a) We will first describe the features of the optical disk format with a barcode formed according to the present embodiment, while dealing with an example of a condition that permits tracking control during playback (this condition is also referred to as the tracking ON condition). A playback operation using tracking control is shown in Figure 16, and its details will be given later.

[0035] In the case of a DVD disk in the present embodiment, all data are recorded in pits with CLV, as shown in Figure 8. Stripes 923 (forming a barcode) are recorded with CAV. CLV recording means recording with constant linear velocity, while CAV recording means recording with constant angular velocity.

[0036] The stripes 923 are recorded with CAV, superimposed on a pre-pit signal in a lead-in data area holding an address which is recorded with CLV. That is, the data is overwritten with the stripes. The pre-pit signal area maps into all the data areas where pits are formed. The prescribed region of the pre-pit signal area corresponds to an inner portion of the optical disk; this region is also called a post-cutting area (PCA). In this PCA area, the barcode is recorded with CAV, superimposed on pre-bit signals. In this way, the CLV data is recorded with a pit pattern from the master disk, while the CAV data is recorded with laser-removed portions of the reflective film. Since the barcode data is written in overwriting fashion, pits are recorded between the barcode stripes 1T, 2T, and 3T. Using this pit information, optical head tracking is accomplished, and Tmax or Tmin of the pit information can be detected; therefore, motor rotational speed is controlled by detecting this signal. To detect Tmin, the relation between the trimming width t of stripe 923a and the pit clock T (pit) should be t > 14T (pit), as shown in Figure 8, to achieve the above effect. If t is shorter than 14T, the pulse width of the signal from the stripe 923a becomes equal to the pulse width of the pit signal, and discrimination between them is not possible, so that the signal from the stripe 923a cannot be demodulated. To enable pit address information to be read at the same radius position as the stripes, an address area 944 is provided longer than a unit of one address of pit information, as shown in Figure 10 address information can thus be obtained, making it possible to jump to the desired track. Furthermore, the ratio of the stripe area to the non-stripe area, that is, the duty ratio, is made less than 50%, i.e., T(S) < T(NS); since the effective reflectivity decreases only by 6 dB, this has the effect of ensuring stable focusing of the optical head.

[0037] Next, we will describe an example of a condition in which tracking control cannot be applied during playback (this condition is also referred to as the tracking OFF condition).

[0038] Since the stripes 923 are written over pits, interrupting pit signals and preventing correct playback of the pit data, tracking control may not be possible on some players. In such players, the strips 923, which are CAV data, can be read by the optical pickup by applying rotational control using a rotational pulse from a Hall element, etc. in the motor 17.

[0039] Figure 9 shows a flowchart illustrating a procedure for operations in a playback apparatus when pit data in the optical tracks in the stripe area cannot be correctly played back.

[0040] In Figure 9, when a disk is inserted in step 930a, the optical head is moved by a prescribed distance to the inner portion in step 930b. The optical head is thus positioned on the area where the stripes 923 of Figure 30 are recorded.

[0041] Here, it is not possible to correctly playback data from all the pits recorded in the stripe area 923. In this case, therefore, usual rotation phase control cannot be applied for the playback of the pit data recorded with CLV.

[0042] In step 930c, rotational speed control is applied by using a rotational sensor of a Hall element in the motor or by measuring the T(max) or T(min) or frequency of a pit signal. If it is determined in step 930i that there are no stripes, the process jumps to step 930f. If there are stripes, the barcode is played back in step 930d, and when playback of the barcode is completed in step 930e, the optical head is moved in step 930f to an outer area where no stripes are recorded. In this area, since no stripes are recorded, the pits are played back correctly and accurate focus and tracking servo are achieved. Since the pit signal can be played back, usual rotation phase control can be performed to rotate the disk with CLV. As a result, in step 930h, the pit signal is played back correctly.

[0043] By switching between the two rotation control modes, i.e., the rotational speed control and the rotation phase control by pit signals, the effect is obtained that two different kinds of data, barcode stripe data and pit-recorded data, can be played back. Since the stripes are recorded in the innermost area, switching means measures the radius position of the optical head from the optical head stopper or from the address of a pit signal, and based on the result of the measurement, correctly performs switching between the two rotation con-

trol modes.

[0044] (b) Referring next to Figures 17 and 18, we will describe two control methods for controlling the rotational speed when playing back the barcode according to the present embodiment.

[0045] Figure 17 shows the first rotational speed control method wherein rotational speed control is applied by detecting Tmax of a bit signal (Tmax means measuring time for a pit having the largest pit length of various pit lengths).

[0046] A signal from the optical head is first subjected to waveshaping, and then the pulse spacing of the pit signal is measured by an edge-spacing measuring means 953. A t0 reference value generating means 956 generates reference value information t0 whose pulse width is larger than the pulse width 14T of the sync signal but smaller than the pulse width t of the barcode signal. This reference value information t0 and the pulse width TR of the reproduced signal are compared in a comparing means 954; only when TR is smaller than the reference value t0 and larger than Tmax held in a memory means 955, TR is supplied to the memory means 955 where TR is set as Tmax. By reference to this Tmax, a controller 957 controls a motor drive circuit 958, achieving motor rotational speed control based on Tmax. In the case of the present invention, numerous pulses at cycles of 3 to 10 μs are generated by barcode stripes. In the case of a DVD, the sync pulse width is 14T, that is, 1.82 μm. On the other hand, the barcode stripe width is 15 μm. In Tmax-based control, the barcode pulse longer than the pulse width 14T of the synch pulse will be erroneously judged and detected as Tmax. Therefore, by removing barcode signals larger than the reference value t0 by comparison with the reference value t0, as shown in Figure 17, it becomes possible to perform rotational speed control for normal rotational speed during the playback of the barcode stripe area.

[0047] Next, the second rotational speed control method will be described with reference to Figure 18. This method performs rotational speed control by detecting Tmin (Tmin means measuring time for a pit having the smallest pit length of various pit lengths).

[0048] In the Tmin-based control shown in Figure 18, the pulse information TR from the edge-spacing detecting means 953 is compared in a comparing means 954a with Tmin held in a memory means 955a; if TR < Tmin, a strobe pulse occurs and the Tmin in the memory is replaced by TR.

[0049] In this case, the barcode pulse width t is 3 to 10 μm, as noted above, while Tmin is 0.5 to 0.8 μm. As a result, if the barcode area is played back, the condition TR < Tmin is not satisfied since the barcode pulse width t is always greater than Tmin. That is, there is no possibility of erroneously judging a barcode pulse as Tmin. Therefore, when the Tmin-based rotational speed control is combined with a barcode reading means 959, the effect is that rotational speed control based on Tmin can be applied more stably while playing back the barcode, compared to the Tmax-based method. Further, an oscillator clock 956 creates a reference clock for demodulation in the barcode reading means 959, while detecting the edge spacing; this has the effect of being able to demodulate the barcode in synchronism with rotation.

[0050] Next, a series of optical disk reproduction operations (playback operations) using the above control methods, etc. will be described.

[0051] Referring first to Figures 9 and 19, a first playback method will be described in conjunction with a method for switching between rotation phase control mode and rotational speed control mode by a mode switch 963. Then, a second and a third playback method for playing back the optical disk of the present embodiment will be described with reference to Figures 15, 16, etc. The first and second playback methods hereinafter described are each concerned with a case where tracking control cannot be performed, while the third playback method is concerned with a case where tracking control can be performed.

[0052] At the same time that the optical head is moved to the inner portion of the disk in steps 930b and 930c in Figure 9, the mode switch 963 shown in Figure 19 is switched to A. Alternatively, the mode switch 963 may be switched to A when it is detected by a pickup (PU) position sensor 962, etc. that the optical head being moved by a moving means 964 has reached the inner portion of the disk.

[0053] Next, an operation when the rotational speed control mode (step 930c in Figure 9) is entered will be described with reference to Figure 19.

[0054] A motor rotation frequency, fm, from a motor 969 and a frequency, f2, of a second oscillator 968 are compared in a second frequency comparator 967, and a difference signal is fed to the motor drive circuit 958 to control the motor 969, thus achieving rotational speed control. In this case, since the disk is rotating with CAV, the barcode stripe can be played back.

[0055] When the barcode playback is completed in step 930e in Figure 9, the head is moved to an outer area by the moving means 964, and at the same time, by a signal from the PU position sensor 962, etc., the mode switch 963 is switched to B for rotation phase control mode.

[0056] In the rotation phase control mode, PLL control is applied to the pit signal from the optical head by a clock extracting means 960. The frequency f1 of a first oscillator 966 and the frequency fS of a reproduced synchronization signal are compared in a first frequency comparator 965, and a difference signal is fed to the motor drive circuit 958. The rotation phase control mode is thus entered. Because of PLL phase control by the pit signal, data synchronized to the synchronization signal of f1 is played back. If the optical head were moved to the barcode stripe area by rotation phase control, without switching between rotational phase control for the motor and rotational speed control for the motor, phase control could not be performed because of the presence

of the stripes, and trouble would occur, such as, the motor running out of control or stopping, an error condition occurring, etc. Therefore, as shown in Figure 19, switching to the appropriate control mode not only ensures stable playback of the barcode but has the effect of avoiding troubles relating to motor rotation.

[0057] The second method for playing back the optical disk of the present embodiment will be described with reference to Figure 15 which shows a flowchart illustrating the operation.

[0058] The second playback method is an improved version of the first playback method.

[0059] More specifically, the first playback method is a method for playing back an optical disk on which a stripe presence/absence identifier 937 is not defined. Since tracking is not applied in the stripe area on an optical disk of this type, it takes time to distinguish between a stripe pattern legally formed on the disk and an irregular pattern caused by scratches on the disk surface. Therefore, regardless of whether the stripes are recorded or not, the playback procedure has to perform a stripe reading operation first, to check the presence or absence of stripes or whether the stripes are recorded in the inner portion of the optical disk. This may cause a problem in that an extra time is required before the data can be actually played back. The second playback method improves on this point.

[0060] First, as shown in Figure 15, when an optical disk is inserted, control data is played back in step 940a. Usually, physical feature information and attribute information of the optical disk are recorded as control data in a control data area. The physical feature information includes, for example, information indicating that the optical disk is a laminated-type disk of a two-layer, single-sided structure.

[0061] In the present invention, as shown in Figure 8, the control data recorded in the control data area 936 of the optical disk contains a PCA stripe presence/absence identifier 937 recorded as a pit signal. Therefore, the optical head is first moved, in step 940n, to an outer area where the control data is recorded. And then the optical head moves inwardly jumping across a plurality of tracks until reaching the control data area 436. And then in step 940a, the control data is played back. It can thus be checked whether the stripes are recorded or not. If, in step 940b, the stripe presence/absence identifier is 0, the process proceeds to step 940f to initiate rotation phase control for normal playback with CLV. On the other hand, if, in step 940b, the presence/absence identifier 937 is 1, then the process proceeds to step 940h to check the presence or absence of a reverse-side record identifier 948 which indicates that the stripes are recorded on the side opposite from the side being played back, that is, on the reverse side. If the stripes are recorded on the reverse side, the process proceeds to step 940i to play back the recording surface on the reverse side of the optical disk. If the reverse side cannot be automatically played back, an indication is output for display, to urge the user to turn over the disk. If it is determined in step 940h that the stripes are recorded on the side being played back, the process proceeds to step 940c, where the head is moved to the stripe area 923 in the inner portion of the disk, and in step 940d, the control mode is switched to rotational speed control to play back the stripes 923 with CAV rotation. If the playback is completed in step 940e, then in step 940f the control mode is switched back to rotation phase control for CLV playback and the optical head is moved to the outer portion of the disk to play back pit signal data.

[0062] Since the stripe presence/absence identifier 937 is recorded in the pit area holding the control data, etc., as described above, the second method has the effect of being able to play back the stripes more reliably and more quickly compared to the first playback method described with reference to Figure 9.

[0063] When the PCA area is with tracking OFF, level of the noise signal which is generated by the pits drops. PCA signal level remains unchanged if tracking is set OFF. Therefore, in the filtered waveform shown in Figure 13(b), the pit signal drops, making it easier to distinguish between the PCA signal and the pit signal. This has the effect of simplifying the circuitry and reducing the error rate.

[0064] Furthermore, the provision of the stripe reverse-side record identifier 948 makes it possible to identify that the stripes are recorded on the reverse side of the disk; the effect is that the barcode stripes can be played back reliably in the case of a double-sided DVD optical disk. According to the present invention, since the stripes are recorded penetrating through the reflective films on both sides of a disk, the stripe pattern can also be read from the reverse side of the disk. The stripes can be played back from the reverse side of the disk by checking the stripe reverse-side identifier 948 and by playing back the code in the reverse direction when reading the stripes. The present invention uses a bit string "01000110" as the synchronization code, as shown in Figure 12(a). When played back from the reverse side, the synchronization code is played back as "01100010", from which it can be detected that the barcode is being played back from the reverse side. In this case, by demodulating the code in reverse direction in the demodulator 942 in the playback apparatus of Figure 15, the barcode recorded in penetrating fashion can be correctly played back even if played back from the reverse side of a double-sided disk. The playback apparatus of Figure 15 will be described in more detail later.

[0065] Further, if, as shown in Figure 8, a 300-μm wide guard-band area 999, where only address information is recorded but no other data is recorded, is provided between the PCA area 998 and the control data area 936, access to the control data can be made more stable.

[0066] The guard-band area 999 will be described in more detail below.

[0067] When the optical head accesses the control data from the outer portion of the disk, the optical head moves inwardly jumping across a plurality of tracks until reaching the control data area 936. In some cases, the optical head may be moved past the destination control data area 936, landing at a portion further inward of the control data area. At this time, if the PCA area 998 exists directly adjacent to the inner circumference of the control data area, the optical head will lose its own position since an address cannot be played back in the PCA area 998. It, then, becomes impossible to control the optical head.

[0068] Accordingly, when the guard-band area with a width, for example, 300 μm, greater than one jump width of the optical head, is provided in the above-noted portion, if the optical head is moved past the control data area 936 the optical head will always land within the guard-band area. Then, by reading an address in the guard-band area, the optical head knows its own position and can thus be repositioned on the destination control data area. In this way, the optical head can be controlled more reliably and more quickly.

[0069] Further, as shown in Figure 8, the control data also contains an additional stripe data presence/absence identifier and a stripe recording capacity. That is, after recording first stripes on an optical disk, additional stripes can be recorded in an empty, unrecorded portion of the area. The first recorded stripes will be referred to as the first set of stripes, and the additionally recorded stripes as the second set of stripes. With this configuration, when the first set of stripes 923 is already recorded by trimming, as shown in Figure 8, the capacity of the available space for trimming the second set of stripes 938 can be calculated. Accordingly, when the recording performs trimming to record the second set of stripes, the control data provides an indication of how much space is available for additional recording; this prevents the possibility of destroying the first set of stripes by recording more than 360° over the area. Furthermore, as shown in Figure 8, a gap 949 longer than one pit-signal frame length is provided between the first set of stripes 923 and the second set of stripes 938; this serves to prevent the previously recorded trimming data from being destroyed.

[0070] Moreover, as shown in Figure 12(b) to be described later, a trimming count identifier 947 is recorded in a synchronization code area. This identifier is used to distinguish between the first set of stripes and the second set of stripes. Without this identifier, discrimination between the first set of stripes 923 and the second set of stripes 938 in Figure 8 would become impossible.

[0071] Finally, the third playback method will be described with reference to Figure 16.

[0072] When the duty ratio of the stripe on the optical disk, that is, its area ratio, is low, almost correct tracking can be maintained in the stripe area, as shown in Figure 10. Therefore, the address information in the address area 944 at the same radius position of the disk can be played back. This has the effect of quickening the disk rise time after disk insertion since the address can be played back while playing back the stripes without changing the optical head position,

[0073] In this case, the address area, an area where no stripes are recorded, should be formed continuously along a length longer than one frame in the same radium portion of the disk.

[0074] The operation steps for this method will be described with reference to Figure 16.

[0075] When a disk is inserted, the optical head is moved to the inner circumferential portion in step 947a. If no tracking is achieved in step 947n, the tracking mode is switched from phase control to push-pull mode in step 947p. In step 947b, rotational speed control (CAV control) is performed to play back address information. If an address cannot be played back in step 947c, the process proceeds to step 947i to move the optical head inward to play back the PCA stripes. If an address can be played back from an empty portion of the PCA area (a portion not overwritten), the process proceeds to step 947e where, based on the address, the optical head is moved in a radial direction to the address area where stripes are recorded. In step 947q, the presence or absence of PCA stripes is checked. If it is judged that there are no PCA stripes, the process proceeds to step 947r to try to read a PCA flag in the control data. Then, in step 947s, the presence or absence of the PCA flag is checked. If the presence of the PCA flag is detected, the process returns to step 947c; otherwise, the process jumps to step 947m.

[0076] On the other hand, if it is judged in step 947q that there are PCA stripes, the process proceeds to step 947f to play back the PCA stripes. When the playback is completed in step 947g, then the mode is switched to rotation phase control and the optical head is moved to the outer area to play back a pit signal. In step 947t, the PCA flag in the control data is read; if there is no PCA flag, an error message is issued in step 947k, and the process returns to 947m to continue the process.

[0077] Figure 15 is a block diagram of the playback apparatus already described above.

[0078] An explanation will be given again referring to Figure 15, focusing on the demodulation operation. First, high-frequency components generated by pits are removed by a low-pass filter (LPF filter) 94 from a stripe signal output.

[0079] In the case of a DVD, there is a possibility that a maximum 14T signal may be played back, where T = 0.13 μm. In this case, it has been confirmed by experiment, a stripe signal and a high-frequency component generated by a pit can be separated by using the second-order or third-order Chevihov low-pass filter shown in Figure 13(a). That is, the use of a second- or higher-order LPF has the effect of being able to separate a pit signal and a barcode signal, thus ensuring stable playback of a barcode. Figure 13(b) shows the simulation waveform which is generated when the signal of the

maximum 14T pit length is recorded continuously.

[0080] In this way, by using the second- or higher-order LPF 943, the stripe playback signal can be output after substantially removing the pit playback signal; this ensures reliable demodulation of stripe signals. However, if the width of a stripe signal thus demodulated (the stripe signal width shown as 15 µm in Figure 14(b)) is smaller than the sampling interval width tm (see Figure 14(c)) of a microcomputer, the stripe signal may not be measured accurately. For example, of the stripe signals shown in Figure 14(b), the stripe signal on the left is located inside of the microcomputer sampling interval width, and therefore, is not detected. To avoid this, a stripe signal obtained by reading a stripe is waveshaped using a flip-flop circuit so that the signal width becomes greater than the microcomputer sampling interval width tm, as shown in Figure 14(d). Figure 14(d) shows a waveform after the stripe signal width was increased to a width Bw. The waveshaped signal is then detected with sampling pulses (see Figure 14(c)) from the microcomputer. This ensures accurate measurement of the stripe signal.

[0081] Referring back to Figure 8, a further description will be given. Digital data is demodulated by the PE-RZ demodulator 942 in the above manner. The data is then fed to an ECC decoder 928 for error correction. That is, deinterleaving is performed in a deinterleaver 928a, and Reed-Solomon code computation is performed in an RS decoder 928b for error correction.

[0082] A brief description will now be given in relation to productive tact.

[0083] Figure 11(a) shows the data structure after the barcode is ECC encoded according to the present embodiment. Figure 11(b) shows the data structure after ECC encoding when n = 1 according to the present embodiment. Figure 33(c) shows an ECC error-correction capability according to the present embodiment.

[0084] In the present invention, the interleaving and Reed-Solomon error-correction coding shown in the data structure of Figure 11(a) are performed using the ECC encoder 927 shown in Figure 1 when recording stripes on an optical disk. With this error-correction method, a read error occurs in only one disk out of 10^7 = 10 million optical disks under the condition of that Byte error rate of 10^{-4} occurs, as shown in Figure 11(c). In this data structure, to reduce the code data length the same sync code is assigned to four rows, reducing the number of sync codes by a factor of 4 and thus increasing efficiency.

With further reference to Figure 11, the scalability of the data structure will be described. In the present invention, the recording capacity can be varied freely, for example, within a range of 12B (12 Byte) to 188B in increments of 16B, as shown in the example of Figure 12(c). That is, n can be changed within a range of n=1 to n=12, as shown in Figure 11(c).

[0085] As shown in Figure 11(b) and Figure 5(a), for example, in the data structure when n=1, there are only four data rows 951a, 951b, 951c, and 951d, followed by ECC rows 952a, 952b, 952c, and 952d. Figure 5(a) is a diagram showing Figure 11(b) in further detail. The data row 951 constitutes EDC of 4B. Figure 5(b) shows this in an equivalent form. Error-correction encoding computation is performed, assuming that data rows from 951e to 951z all contain 0s. Mathematical equations for EDC and ECC computations are shown in Figures 5(c) and 5(d), respectively. In this way, the data is ECC-encoded by the ECC encoder 927 in the recording apparatus of Figure 1 and recorded as a barcode on the disk. When n=1, data of 12B is recorded over an angle of 51 degrees on the disk. Likewise, when n=2, data of 18B can be recorded; when n=12, data of 271B can be recorded over an angle of 336 degrees on the disk. By encoding and decoding the data using the EDC and ECC computation equations shown in Figures 5(c) and 5(d), when the data amount is smaller than 188B, the computation is performed assuming all remaining bits are 0s, so that the data is stored with a small recording capacity. This serves to shorten the productive tact. When performing laser trimming, as in the present invention, the above-described scalability has a significant meaning. More specifically, when performing laser trimming at a factory, it is important to shorten the productive tact. With a slow-speed apparatus which trims one stripe at a time, it will take more than 10 seconds to record a few thousand stripes to the full capacity. The time required for disk production is 4 seconds per disk; if full-capacity recording has to be done, the productive tact increases. On the other hand, for the moment, disk ID number will be a main application area of the present invention; in this application, the PCA area capacity can be as low as 10B. If 271B are recorded when only 10B need to be written, the laser processing time will increase by a factor of 6, leading to a production cost increase. The scalability method of the present invention achieves reductions in production cost and time.

[0086] In the playback apparatus shown in Figure 8, when n=1 as in Figure 11(b), for example, the ECC decoder 928 performs the EDC and ECC error-correction computations shown in Figures 5(c) and 5(d), assuming that the data rows 951e to 951z all contain 0s as shown in Figure 5(b); the effect of this is that data of 12 to 271B can be corrected for errors by using the same program. In this case, the number of program steps decreases, permitting the use of a small-capacity ROM in the microcomputer.

[0087] Furthermore, the pulse width reproduced from each stripe width is made less than 1/2 of one pulse period, as shown in Figure 14. Since there are three difference pulse spacings, 1T, 2T, and 3T, the ratio of the sum of all the stripe areas in one track to the total area of the track is less than 1/3. With this arrangement, in the case of a disk of standard reflectivity of 70% the reflectivity of the stripe area is 2/3 of that, i.e., about 50%. Since this value is enough for focus control, the PCA area can be played back on a conventional ROM disk

player.

Claims

1. An optical disk reproducing apparatus for reproducing information on an optical disk where a first signal is recorded by bit pattern with a first recording clock T1 and a second signal is recorded with overlapping state on said first signal with a second recording clock T2 (≥14T1), comprising:
high frequency suppressing means (943) for suppressing a signal having a frequency which is higher than a predetermined frequency, wherein said high frequency suppressing means is provided with a reproduced information and is adapted to suppress said first signal to extract said second signal at its output.

2. An optical disk reproducing apparatus according to claim 1, wherein said high frequency suppressing means is a low pass filter (943).

3. An optical disk reproducing apparatus wherein recorded contents of a recording area on which a main information recorded by forming pits on an optical disk, are reproduced by an optical head with using a rotational phase control for a motor while recorded contents of a different recording area other than said recording area on which such information is recorded by selectively forming low-reflectivity marks are reproduced by an optical head with using rotational speed control for said motor (940d) and thereby the main information recorded on said recording area and the sub-information recorded on said different recording area are both reproduced by using the same optical pickup.

4. An optical disk reproducing apparatus according to claim 3, wherein tracking control is not performed in said different recording area (940c).

5. An optical disk reproducing apparatus according to claim 3, wherein tracking control is, in effect, performed in said recording area (940g).

6. An optical disk reproducing apparatus according to claim 5, wherein said rotational speed is the rotational speed that would be achieved in said different recording area if said rotational phase control were applied.

7. An optical disk reproducing apparatus according to claim 5, wherein the rotational speed of said motor in said rotational speed control is maintained at a prescribed value based on a result (955a) obtained by measuring a minimum-length pit in said different recording area.

8. An optical disk reproducing apparatus according to claim 5, wherein said marks are a barcode-like pattern formed on a circle of a predetermined radius.

9. An optical disk reproducing apparatus according to claim 5, wherein

    said marks are a barcode-like pattern, and said different recording area is recorded with pits, and

    when reproducing the recorded contents of said different recording area, a high-frequency-component signal generated during reproduction of said pits on said different recording area is reduced or eliminated by a low-pass filter (943) thereby making it possible to separate a signal which is reproduced from said barcode.

10. An optical disk reproducing apparatus according to claim 5, wherein
said marks are a barcode-like pattern and when reproducing the recorded contents of said different recording area, the width of a signal obtained by reading said barcode is increased to a prescribed width (8W) and then measured with sampling pulses from a control section.

11. An optical disk reproducing apparatus according to any one of claims 5 to 10, wherein said optical disk is constructed from two disk-substrates laminated together.

12. An optical disk reproducing apparatus according to claim 5, wherein said optical disk includes a control data area for holding therein physical feature information concerning said optical disk, and an identifier (937) indicating the presence or absence of said barcode is recorded in said control data area.

13. An optical disk reproducing apparatus according to claim 12, wherein, after reading recorded contents of said control data area (940a) and judging the presence or absence of said barcode, it is determined whether an optical pickup should be moved to an inner portion (940c) or an outer portion (940f) of said optical disk.

Fig. 1

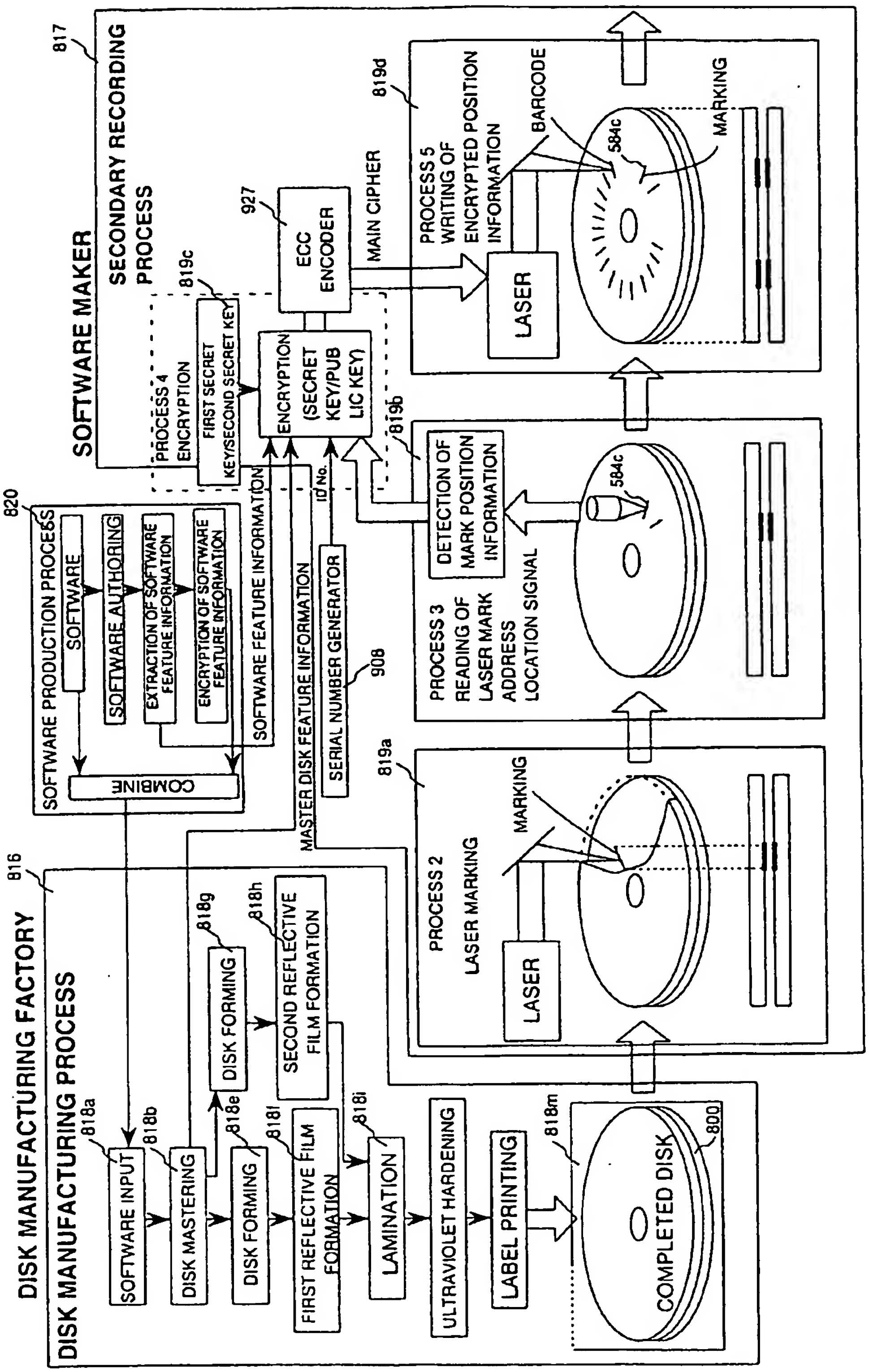

DISK MANUFACTURING FACTORY
DISK MANUFACTURING PROCESS
816
SOFTWARE INPUT
DISK MASTERING
DISK FORMING
FIRST REFLECTIVE FILM FORMATION
LAMINATION
ULTRAVIOLET HARDENING
LABEL PRINTING
COMPLETED DISK
800
818a
818b
818e
818f
818i
818m
DISK FORMING
818g
SECOND REFLECTIVE FILM FORMATION
818h
SOFTWARE PRODUCTION PROCESS
820
SOFTWARE
SOFTWARE AUTHORING
EXTRACTION OF SOFTWARE FEATURE INFORMATION
ENCRYPTION OF SOFTWARE FEATURE INFORMATION
COMBINE
SOFTWARE FEATURE INFORMATION
MASTER DISK FEATURE INFORMATION
SERIAL NUMBER GENERATOR
908
ID No.
SOFTWARE MAKER
SECONDARY RECORDING PROCESS
817
PROCESS 4 ENCRYPTION
FIRST SECRET KEY/SECOND SECRET KEY
819c
ENCRYPTION (SECRET KEY/PUBLIC KEY)
ECC ENCODER
927
MAIN CIPHER
PROCESS 2
LASER MARKING
LASER
MARKING
819a
PROCESS 3
READING OF LASER MARK ADDRESS LOCATION SIGNAL
DETECTION OF MARK POSITION INFORMATION
584c
819b
PROCESS 5
WRITING OF ENCRYPTED POSITION INFORMATION
LASER
BARCODE
584c
MARKING
819d

Fig. 2

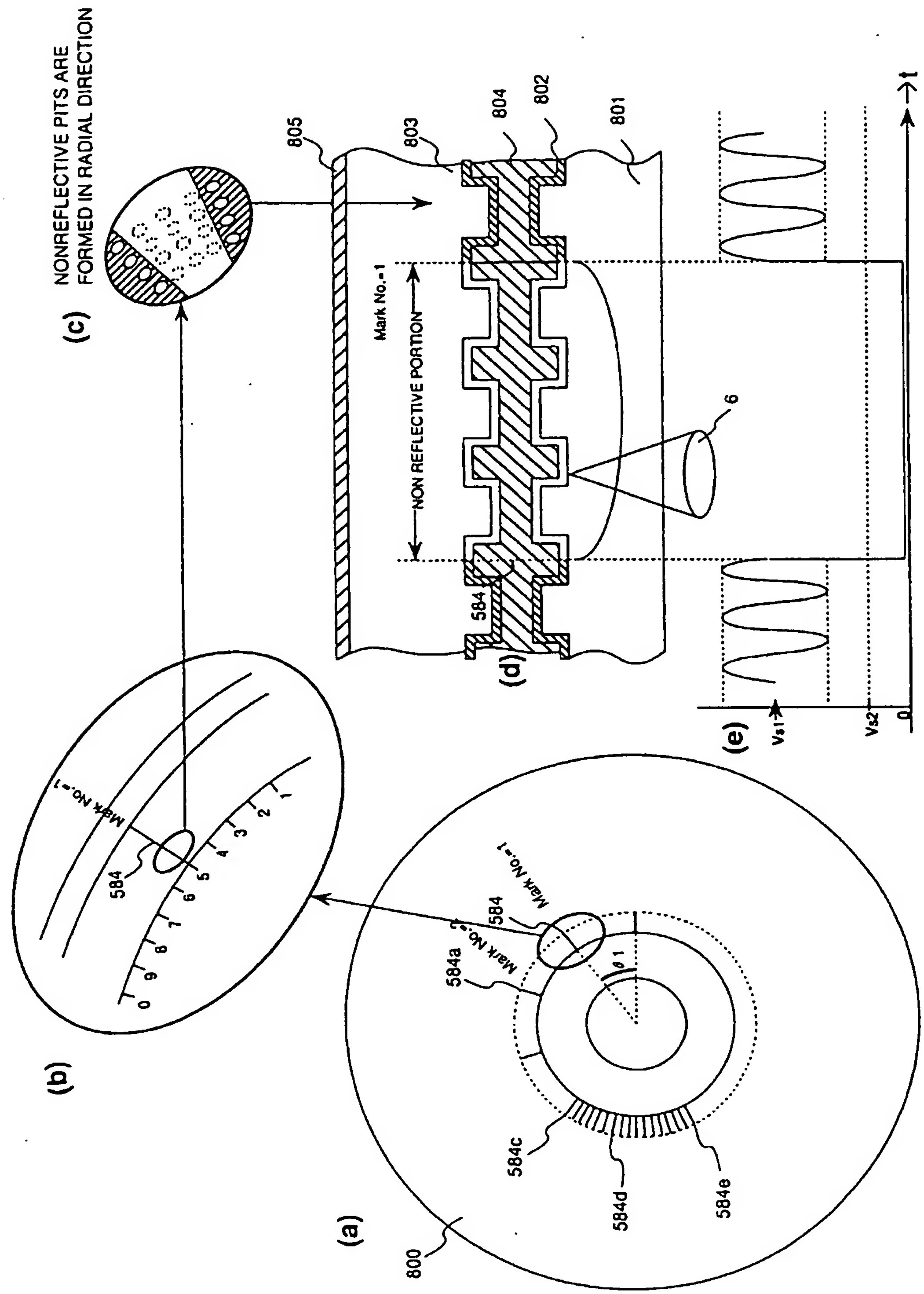

(a)
(b)
(c)
(d)
(e)
NONREFLECTIVE PITS ARE FORMED IN RADIAL DIRECTION
805
803
804
802
801
Mark No.=1
NON REFLECTIVE PORTION
6
584
Vs1
Vs2
0
t
584a
584c
584d
584e
800
Mark No.=2
θ1
0
1
2
3
4
5
6
7
8
9

Fig.3

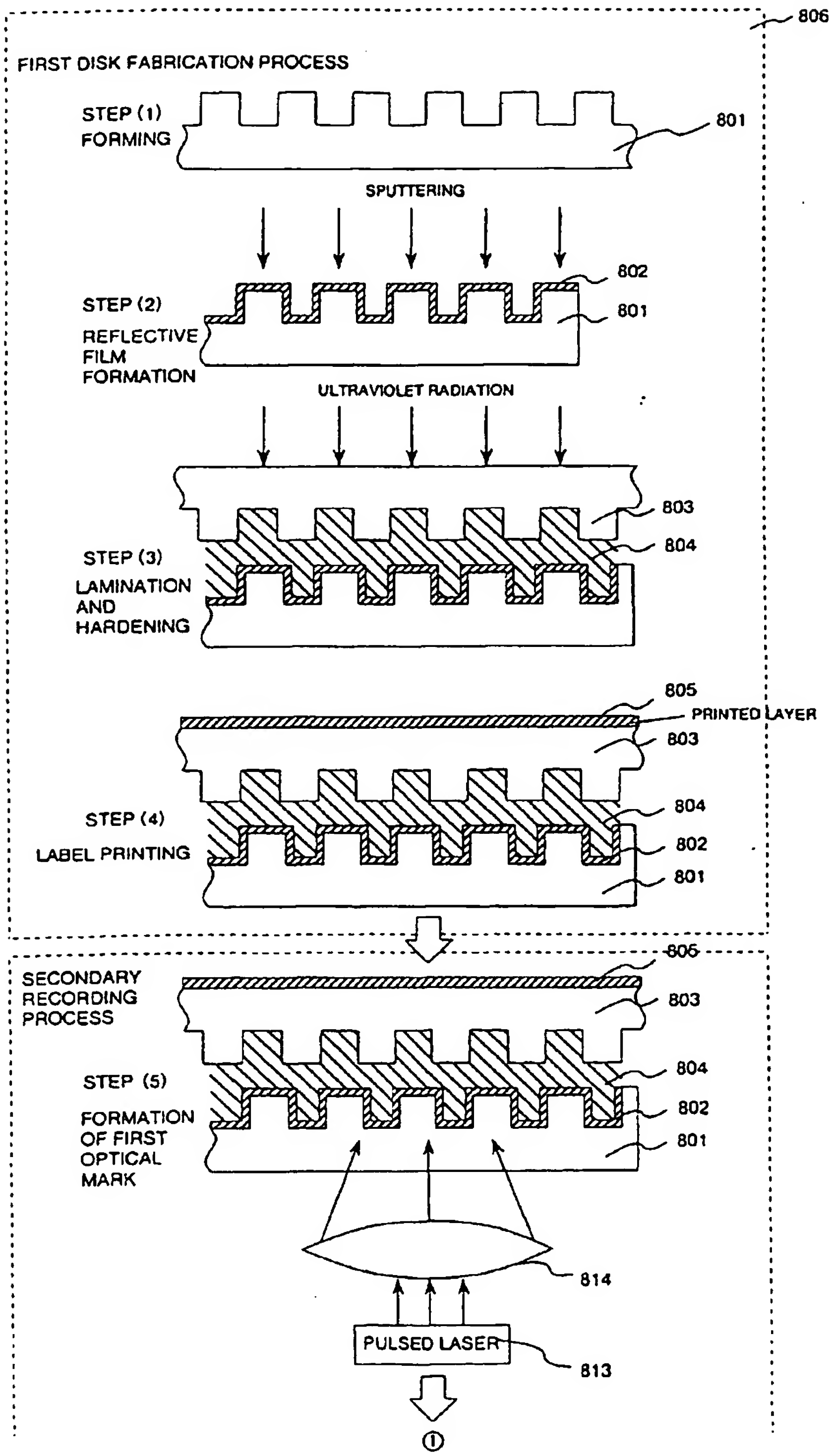

FIRST DISK FABRICATION PROCESS
STEP (1) FORMING
801
SPUTTERING
802
STEP (2) REFLECTIVE FILM FORMATION
801
ULTRAVIOLET RADIATION
803
804
STEP (3) LAMINATION AND HARDENING
805
PRINTED LAYER
803
804
STEP (4) LABEL PRINTING
802
801
806
SECONDARY RECORDING PROCESS
805
803
STEP (5) FORMATION OF FIRST OPTICAL MARK
804
802
801
814
PULSED LASER
813
①

Fig. 4

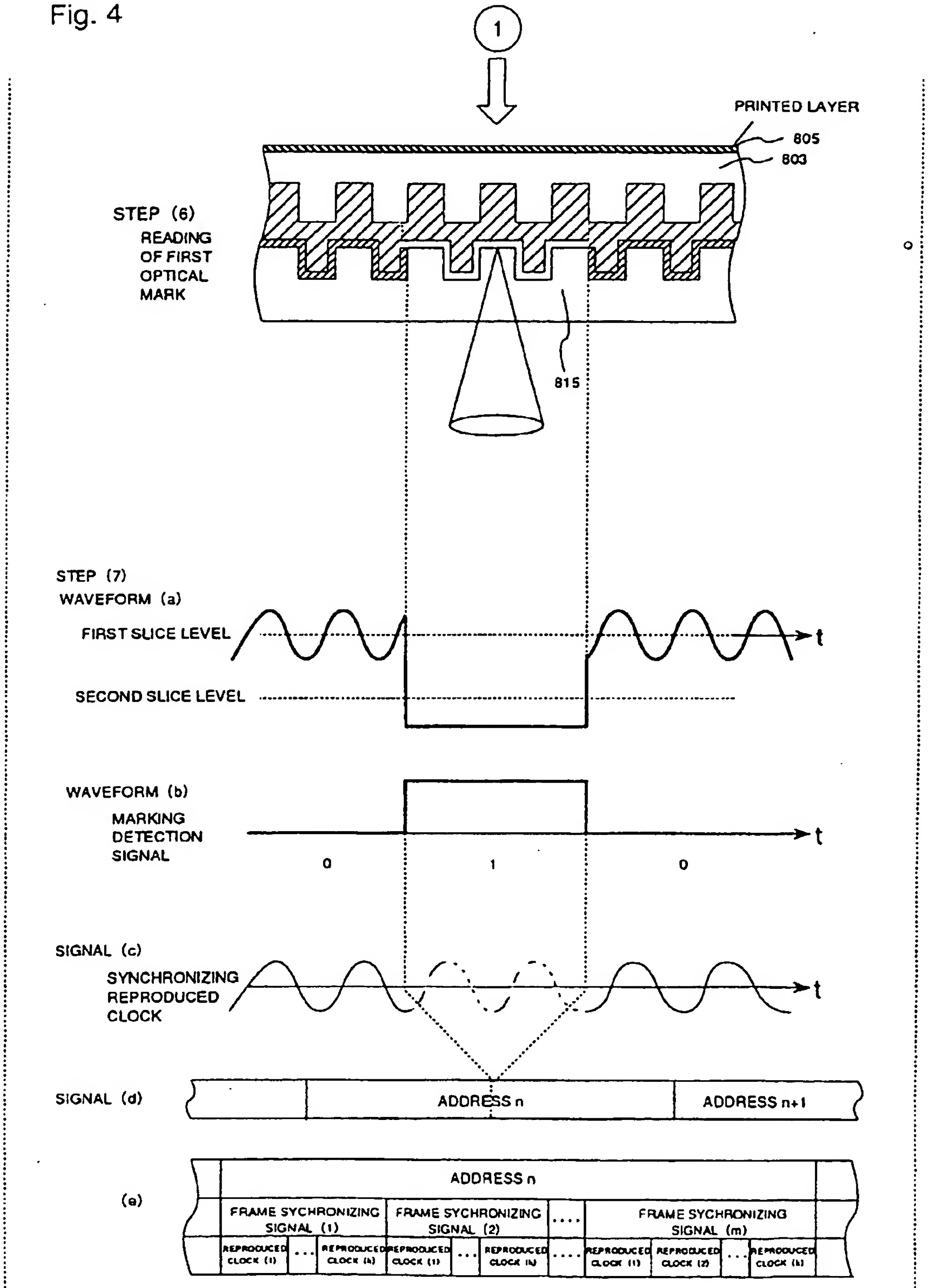
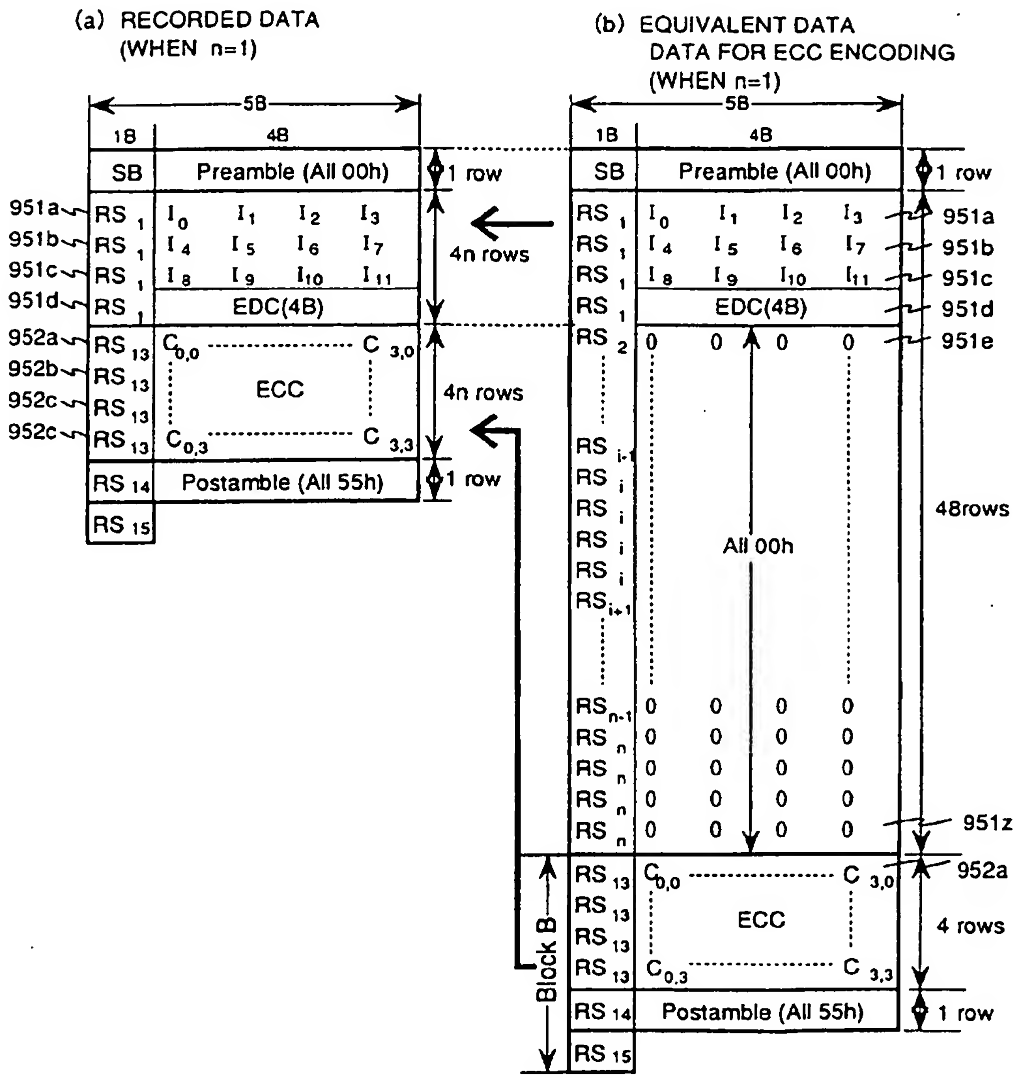

1
PRINTED LAYER
805
803
STEP (6)
READING OF FIRST OPTICAL MARK
815
STEP (7)
WAVEFORM (a)
FIRST SLICE LEVEL
SECOND SLICE LEVEL
t
WAVEFORM (b)
MARKING DETECTION SIGNAL
0
1
0
t
SIGNAL (c)
SYNCHRONIZING REPRODUCED CLOCK
t
SIGNAL (d)
ADDRESS n
ADDRESS n+1
(e)
ADDRESS n
FRAME SYCHRONIZING SIGNAL (1)
FRAME SYCHRONIZING SIGNAL (2)
FRAME SYCHRONIZING SIGNAL (m)
REPRODUCED CLOCK (1)
REPRODUCED CLOCK (k)
REPRODUCED CLOCK (1)
REPRODUCED CLOCK (k)
REPRODUCED CLOCK (1)
REPRODUCED CLOCK (2)
REPRODUCED CLOCK (k)

Fig. 5



(c) TYPICAL EQUATION FOR EDC COMPUTATION EDC (Error Detection Code) :

$$EDC_{PCA}(x) = \sum_{i=0}^{31} bi \cdot x^{i}$$

$$I_{PCA}(x) = \sum_{i=32}^{128n-31} bi \cdot x^{i}$$

(d) TYPICAL EQUATION FOR EDC COMPUTATION ECC (Error Correction Code) :

$$R_{PCA}(x) = \sum_{i=48}^{51} I_{j+4i} \cdot x^{51-i}$$

$$I_{PCA}(x) = \sum_{i=0}^{4n-2} I_{j+4i} \cdot x^{51-i} + D_{j} \cdot x^{52-4n},$$

Fig. 6

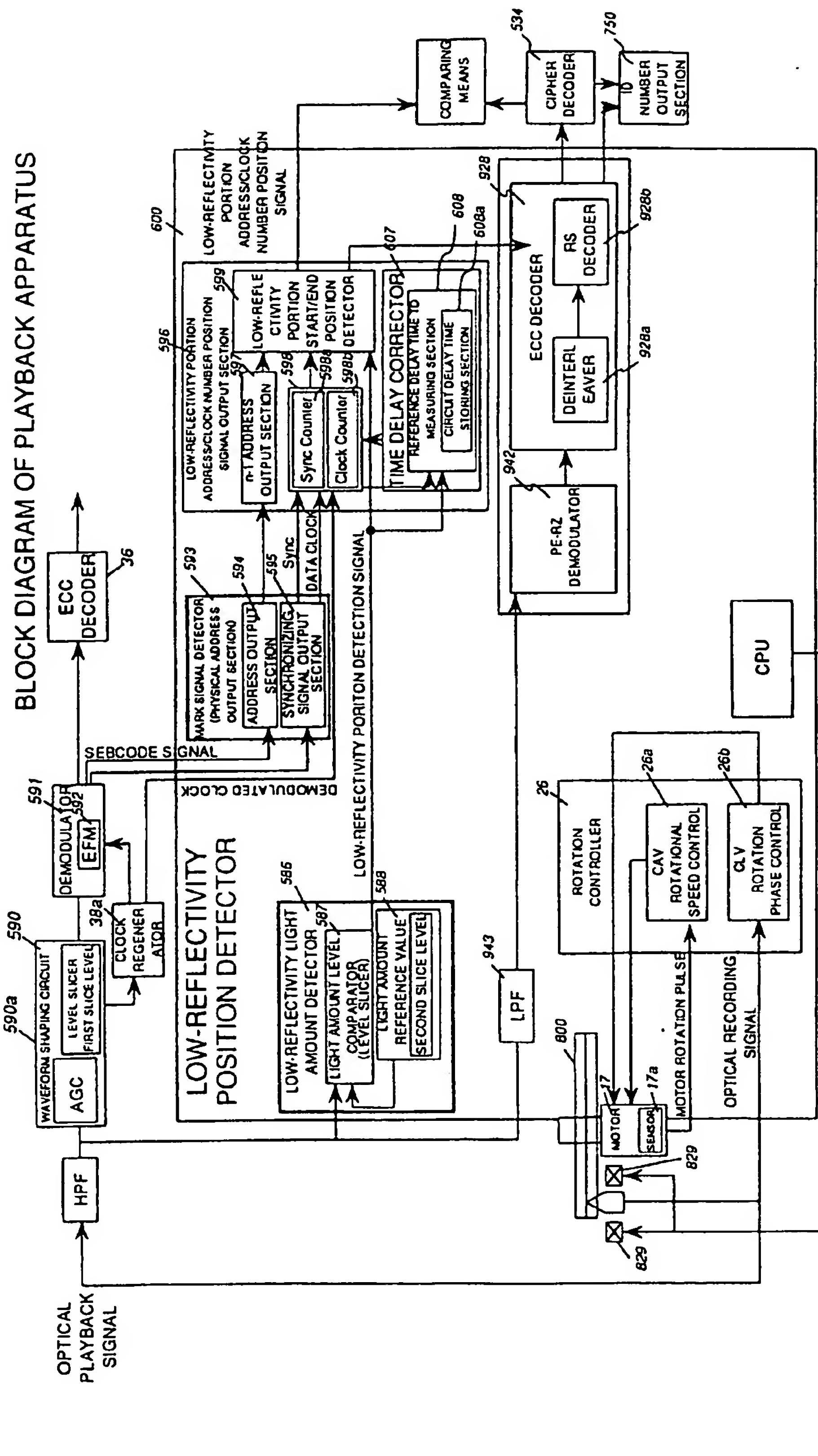

BLOCK DIAGRAM OF PLAYBACK APPARATUS
OPTICAL PLAYBACK SIGNAL
HPF
WAVEFORM SHAPING CIRCUIT
AGC
LEVEL SLICER FIRST SLICE LEVEL
590
590a
38a
CLOCK REGENERATOR
591
DEMODULATOR
EFM
592
ECC DECODER
36
SEBCODE SIGNAL
DEMODULATED CLOCK
593
MARK SIGNAL DETECTOR (PHYSICAL ADDRESS OUTPUT SECTION)
ADDRESS OUTPUT SECTION
SYNCHRONIZING SIGNAL OUTPUT SECTION
594
595
Sync
DATA CLOCK
600
596
LOW-REFLECTIVITY PORTION ADDRESS/CLOCK NUMBER POSITION SIGNAL OUTPUT SECTION
597
n-1 ADDRESS OUTPUT SECTION
598
598a
598b
Sync Counter
Clock Counter
599
LOW-REFLECTIVITY PORTION START/END POSITION DETECTOR
607
TIME DELAY CORRECTOR
REFERENCE DELAY TIME TD MEASURING SECTION
CIRCUIT DELAY TIME STORING SECTION
608
608a
LOW-REFLECTIVITY PORTION ADDRESS/CLOCK NUMBER POSITION SIGNAL
LOW-REFLECTIVITY PORITON DETECTION SIGNAL
LOW-REFLECTIVITY POSITION DETECTOR
586
LOW-REFLECTIVITY LIGHT AMOUNT DETECTOR
587
LIGHT AMOUNT LEVEL COMPARATOR (LEVEL SLICER)
588
LIGHT AMOUNT REFERENCE VALUE
SECOND SLICE LEVEL
COMPARING MEANS
534
CIPHER DECODER
750
ID NUMBER OUTPUT SECTION
928
ECC DECODER
DEINTERLEAVER
RS DECODER
928a
928b
942
PE-RZ DEMODULATOR
943
LPF
CPU
827
1ST LAYER/2ND LAYER SWITCHING SECTION
828
FOCUS DRIVER
26
ROTATION CONTROLLER
26a
CAV ROTATIONAL SPEED CONTROL
26b
CLV ROTATION PHASE CONTROL
800
17
MOTOR
17a
SENSOR
MOTOR ROTATION PULSE
OPTICAL RECORDING SIGNAL
829

Fig. 7

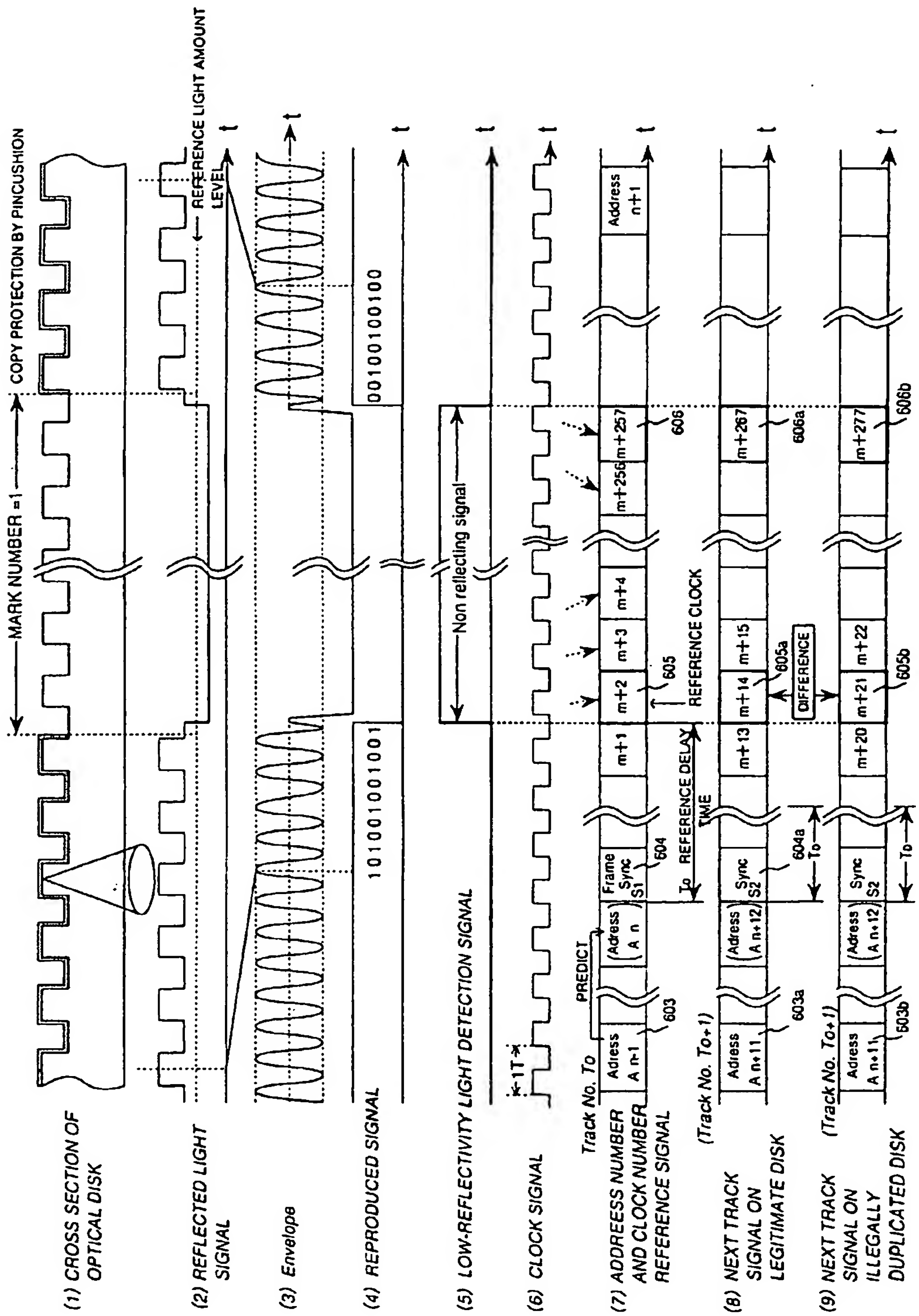

(1) CROSS SECTION OF OPTICAL DISK
(2) REFLECTED LIGHT SIGNAL
(3) Envelope
(4) REPRODUCED SIGNAL
(5) LOW-REFLECTIVITY LIGHT DETECTION SIGNAL
(6) CLOCK SIGNAL
(7) ADDREESS NUMBER AND CLOCK NUMBER REFERENCE SIGNAL
(8) NEXT TRACK SIGNAL ON LEGITIMATE DISK
(9) NEXT TRACK SIGNAL ON ILLEGALLY DUPLICATED DISK
MARK NUMBER =1
COPY PROTECTION BY PINCUSHION
REFERENCE LIGHT AMOUNT LEVEL
Non reflecting signal
1 0 1 0 0 1 0 0 1 0 0 1
0 0 1 0 0 1 0 0 1 0 0
1T
Track No. To
(Track No. To+1)
(Track No. To+1)
PREDICT
REFERENCE CLOCK
REFERENCE DELAY TIME
DIFFERENCE
Adress A n-1
Adress A n
Frame Sync S1
m+1
m+2
m+3
m+4
m+256
m+257
Address n+1
Adress A n+11
Adress A n+12
Sync S2
m+13
m+14
m+15
m+267
m+20
m+21
m+22
m+277
603
604
605
606
603a
604a
605a
606a
603b
605b
606b
To

Fig. 8

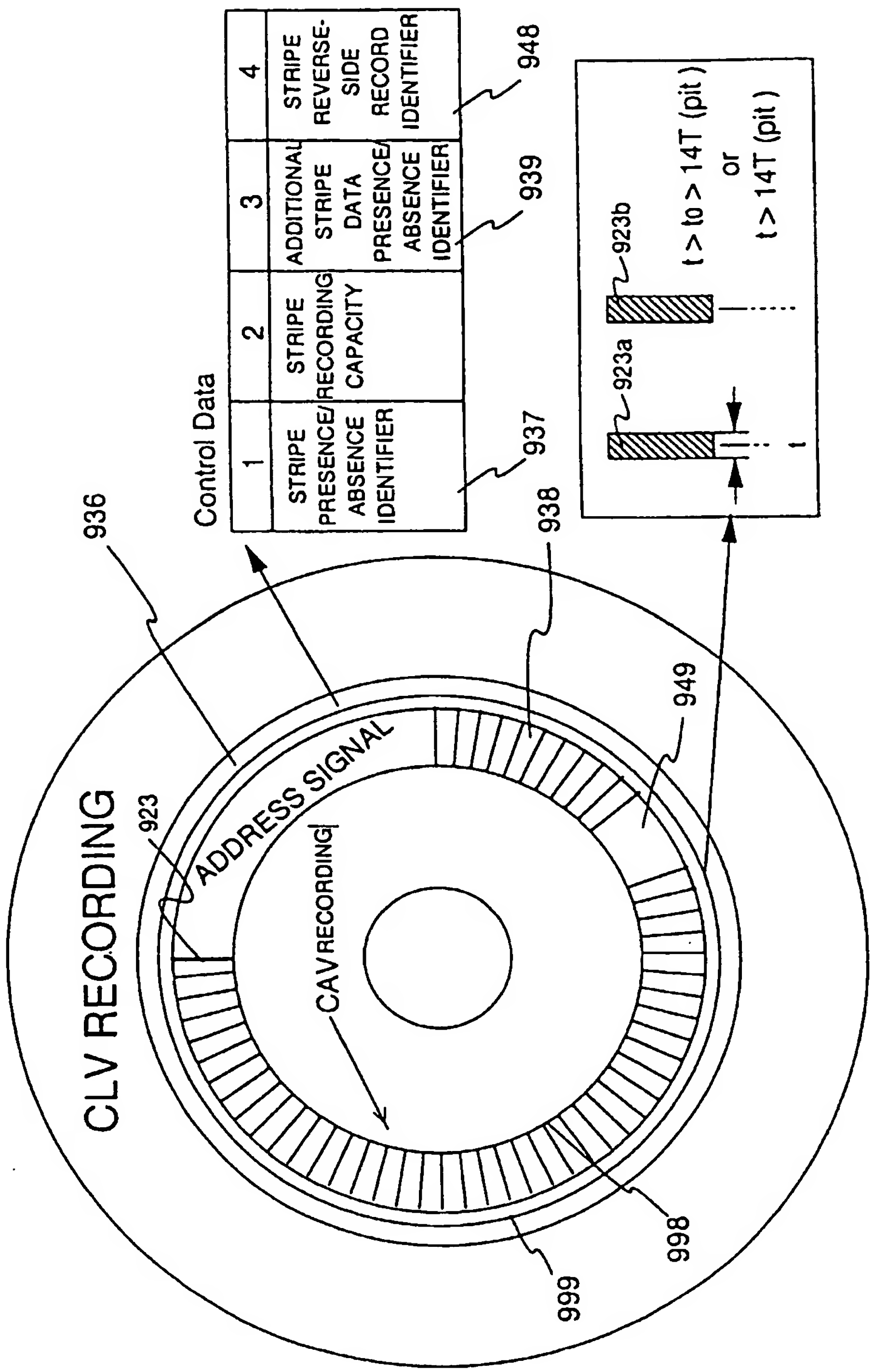

CLV RECORDING
ADDRESS SIGNAL
CAV RECORDING
923
936
938
949
998
999
Control Data
1
2
3
4
STRIPE PRESENCE/ ABSENCE IDENTIFIER
STRIPE RECORDING CAPACITY
ADDITIONAL STRIPE DATA PRESENCE/ ABSENCE IDENTIFIER
STRIPE REVERSE-SIDE RECORD IDENTIFIER
937
939
948
923a
923b
t
t > t0 > 14T (pit)
or
t > 14T (pit)

Fig.9

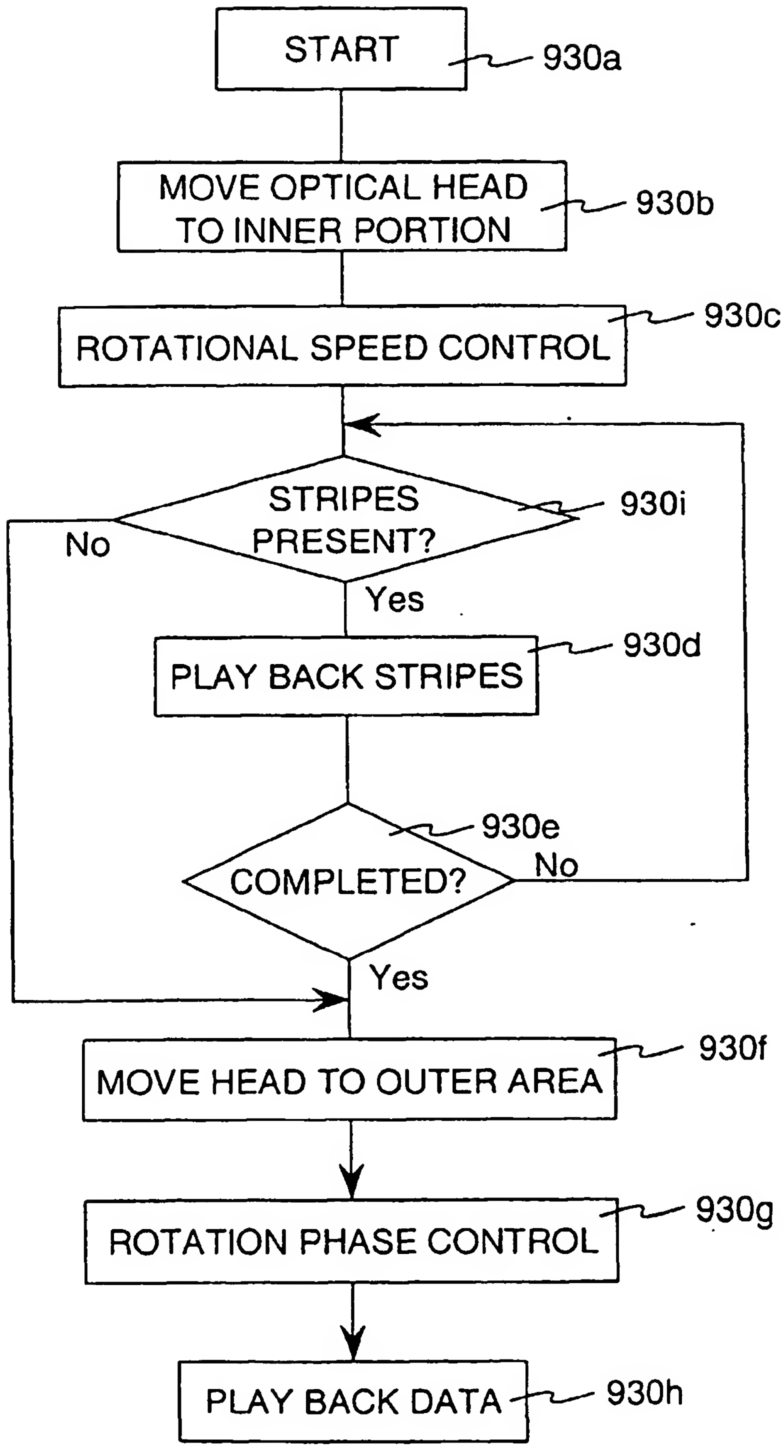

START
930a
MOVE OPTICAL HEAD TO INNER PORTION
930b
ROTATIONAL SPEED CONTROL
930c
STRIPES PRESENT?
930i
No
Yes
PLAY BACK STRIPES
930d
COMPLETED?
930e
No
Yes
MOVE HEAD TO OUTER AREA
930f
ROTATION PHASE CONTROL
930g
PLAY BACK DATA
930h

Fig.10

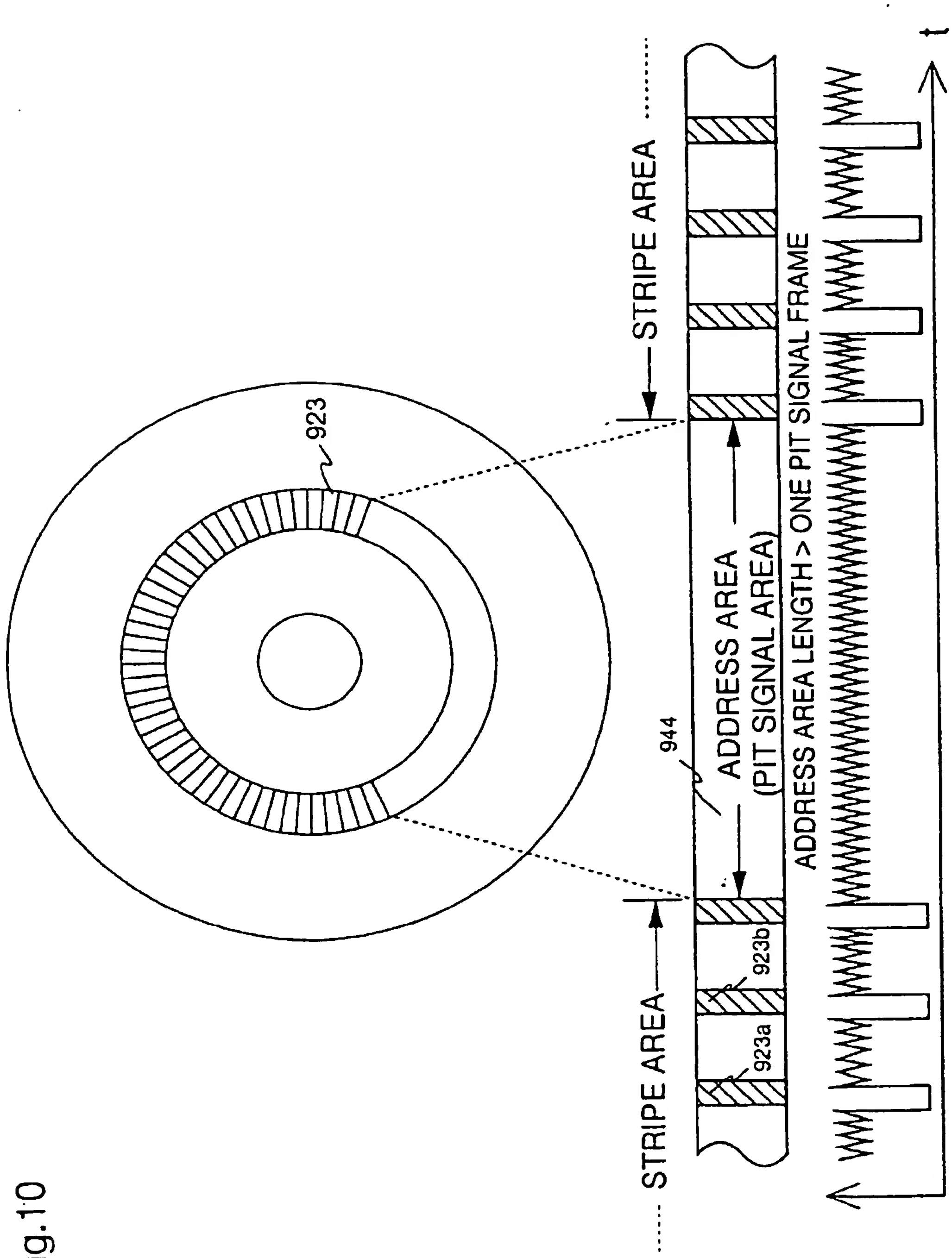
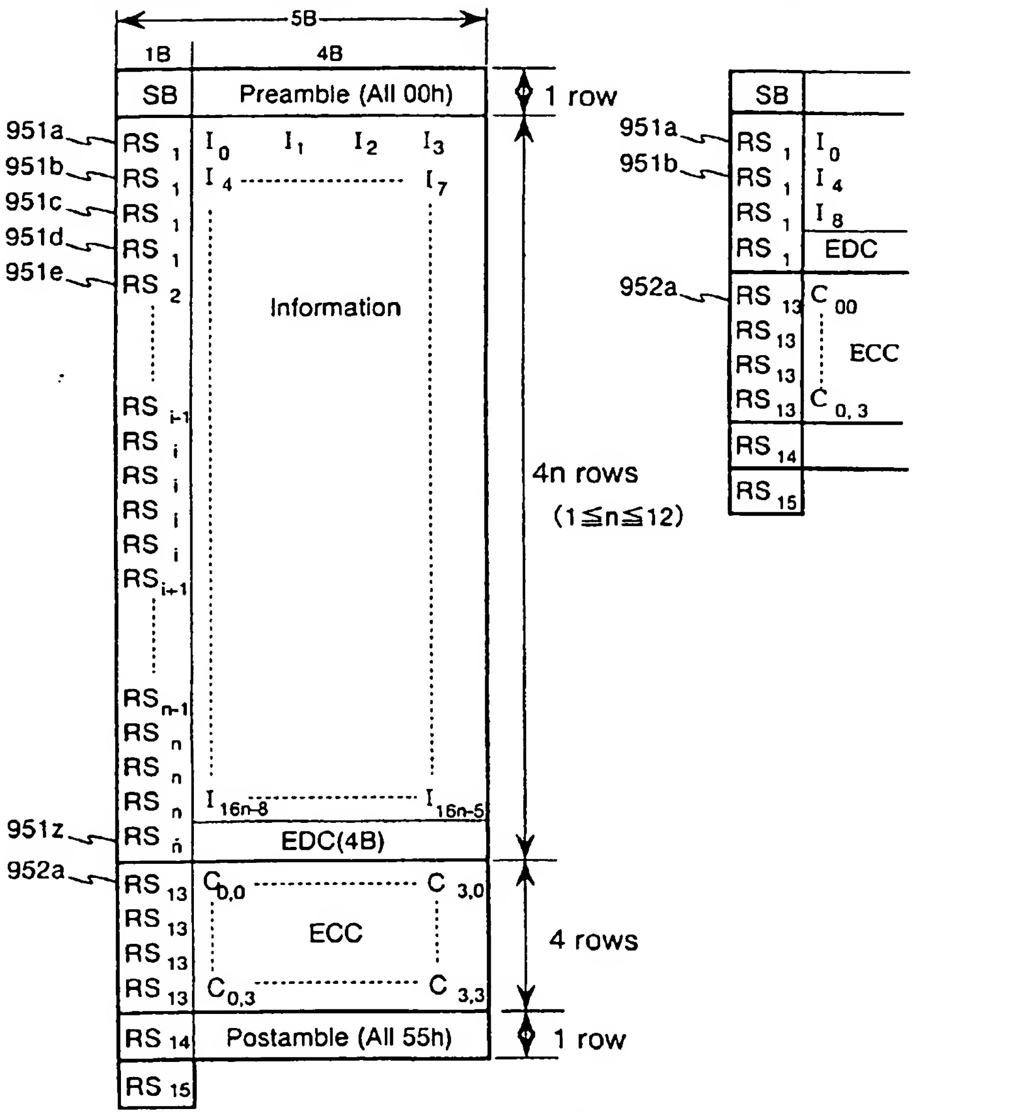

923
944
STRIPE AREA
ADDRESS AREA
(PIT SIGNAL AREA)
STRIPE AREA
923b
923a
ADDRESS AREA LENGTH > ONE PIT SIGNAL FRAME
t

Fig. 11

(a) DATA STRUCTURE (b) DATA STRUCTURE WHEN n=1



(c) RANDOM ERROR CORRECTION CAPABILITY

BIT ERROR RATE BEFORE CORRECTION	READ ERROR RATE AFTER CORRECTION
10^{-5}	1 IN 10^{10} DISKS
10^{-4}	1 IN 10^{7} DISKS
10^{-3}	1 IN 10^{4} DISKS
BURST ERROR CORRECTION CAPABILITY	

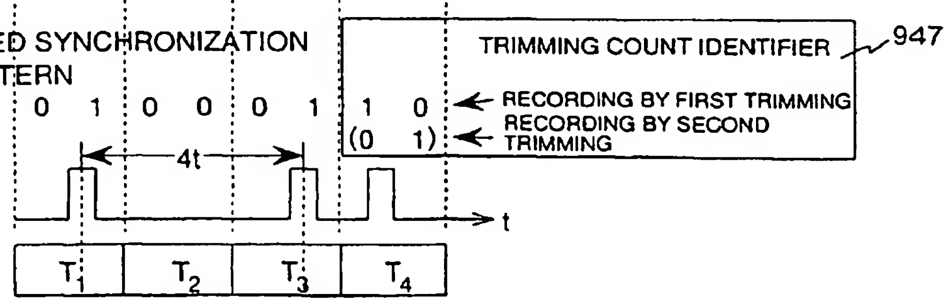
Fig. 12

(a) SYNCHRONIZATION CODE DATA

SYNCHRONIZATION CODE

Sync Byte / Resync	Bit Pattern											
	Fixed Pattern (Channel bit)								Sync Code (Data bit)			
	C_{15}	C_{14}	C_{13}	C_{12}	C_{11}	C_{10}	C_9	C_8	b_3	b_2	b_1	b_0
SB	0	1	0	0	0	1	1	0	0	0	0	0
RS_1	0	1	0	0	0	1	1	0	0	0	0	1
RS_2	0	1	0	0	0	1	1	0	0	0	1	0
⋮										⋮		
RS_i	0	1	0	0	0	1	1	0		i		
⋮										⋮		
RS_{15}	0	1	0	0	0	1	1	0	1	1	1	1

(b) FIXED SYNCHRONIZATION PATTERN

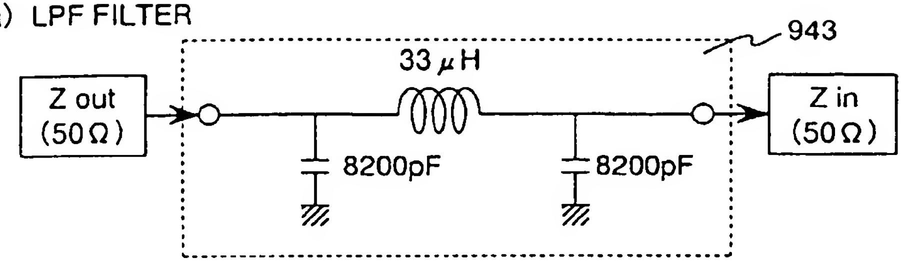


(c) MAXIMUM CAPACITY

	RECORDING CAPACITY	TOTAL BYTE COUNT	EFFICIENCY	RECORDING AREA ANGLE	UNRECORDED AREA ANGLE
MINIMUM	12B	41B	29.3%	51 DEGREES	309 DEGREES
MAXIMUM	188B	271B	69.4%	336 DEGREES	24 DEGREES

Fig. 13

(a) LPF FILTER



(b) SIMULATOR WAVEFORM AFTER LPF : $I_{14L} = I_S = 0.1$

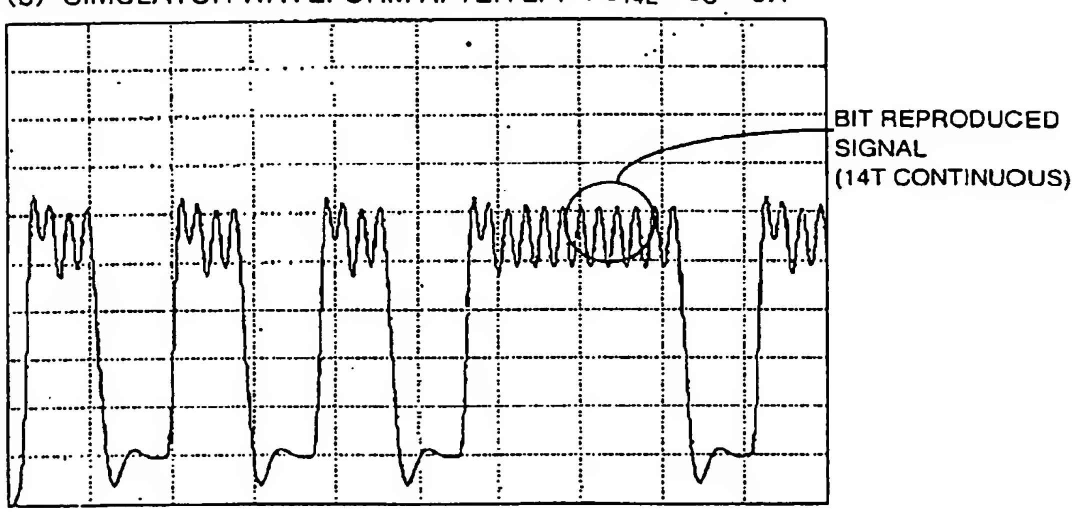


Fig.14

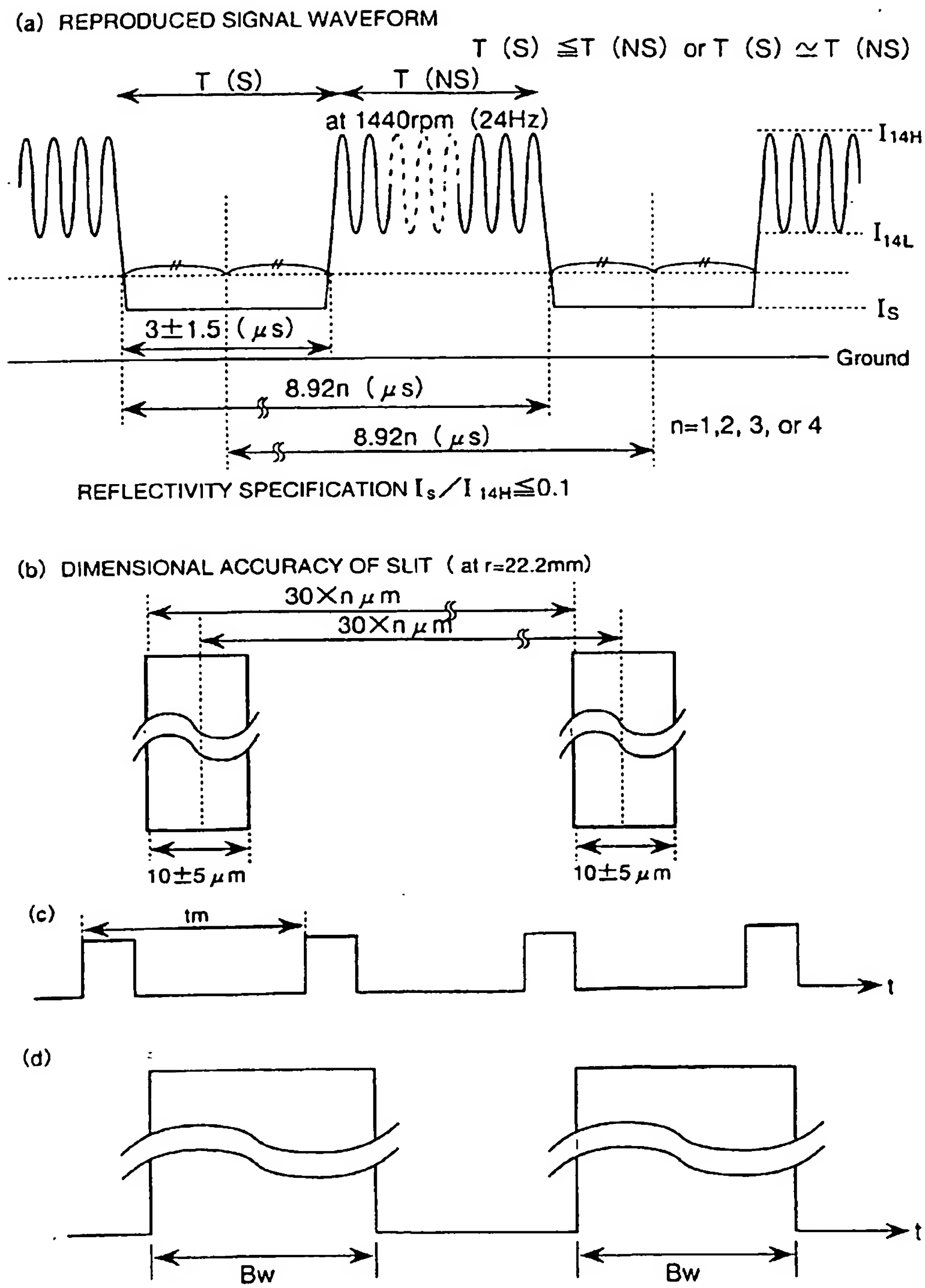

(a) REPRODUCED SIGNAL WAVEFORM
T (S) ≦T (NS) or T (S) ≃T (NS)
T (S)
T (NS)
at 1440rpm (24Hz)
I_{14H}
I_{14L}
I_S
3±1.5 (μs)
Ground
8.92n (μs)
8.92n (μs)
n=1,2, 3, or 4
REFLECTIVITY SPECIFICATION I_S/I_{14H}≦0.1
(b) DIMENSIONAL ACCURACY OF SLIT (at r=22.2mm)
30×n μm
30×n μm
10±5 μm
10±5 μm
(c)
tm
t
(d)
Bw
Bw
t

Fig. 15

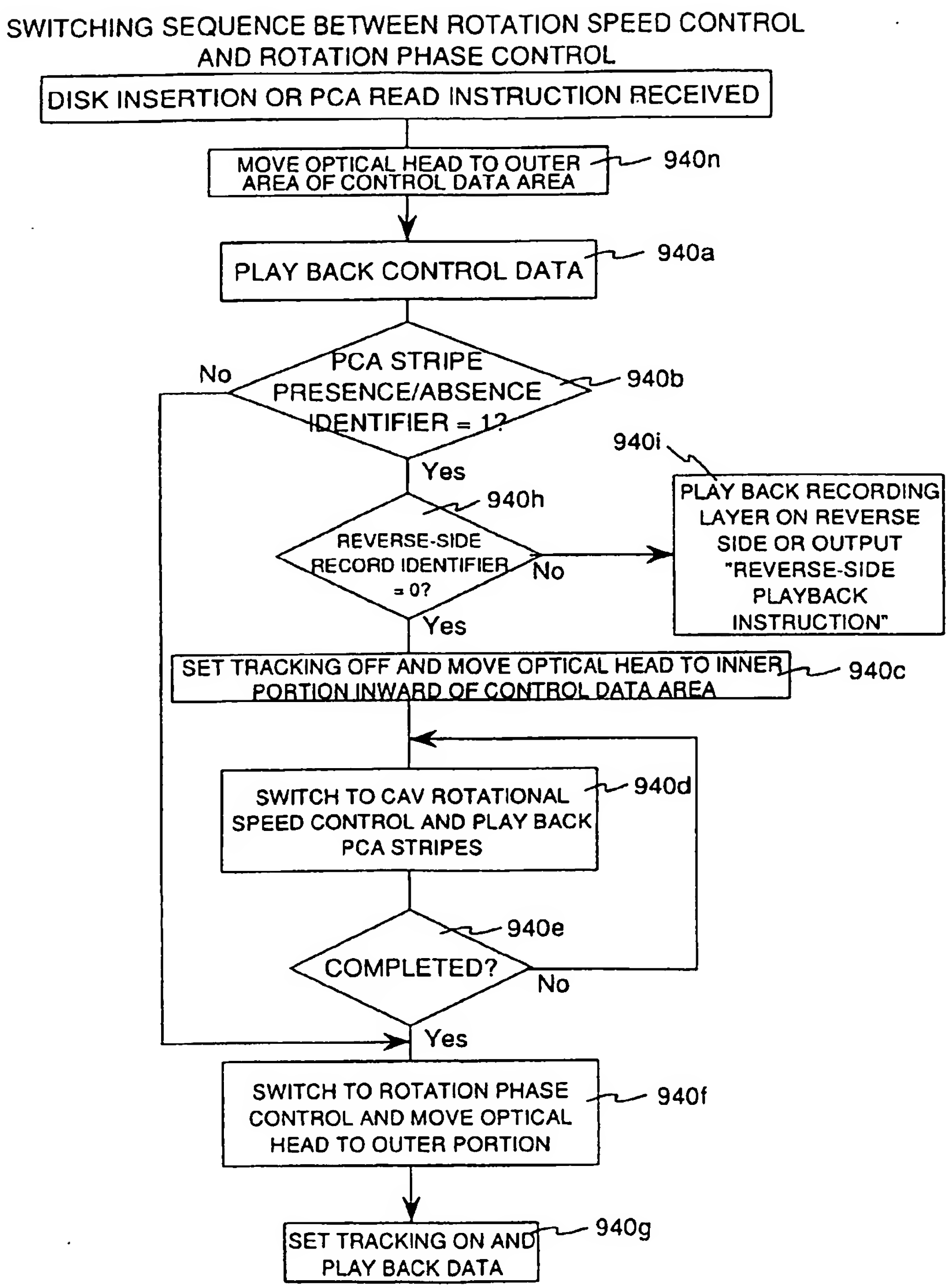

SWITCHING SEQUENCE BETWEEN ROTATION SPEED CONTROL AND ROTATION PHASE CONTROL
DISK INSERTION OR PCA READ INSTRUCTION RECEIVED
MOVE OPTICAL HEAD TO OUTER AREA OF CONTROL DATA AREA
940n
PLAY BACK CONTROL DATA
940a
PCA STRIPE PRESENCE/ABSENCE IDENTIFIER = 1?
940b
No
Yes
REVERSE-SIDE RECORD IDENTIFIER = 0?
940h
No
PLAY BACK RECORDING LAYER ON REVERSE SIDE OR OUTPUT "REVERSE-SIDE PLAYBACK INSTRUCTION"
940i
Yes
SET TRACKING OFF AND MOVE OPTICAL HEAD TO INNER PORTION INWARD OF CONTROL DATA AREA
940c
SWITCH TO CAV ROTATIONAL SPEED CONTROL AND PLAY BACK PCA STRIPES
940d
COMPLETED?
940e
No
Yes
SWITCH TO ROTATION PHASE CONTROL AND MOVE OPTICAL HEAD TO OUTER PORTION
940f
SET TRACKING ON AND PLAY BACK DATA
940g

Fig. 16

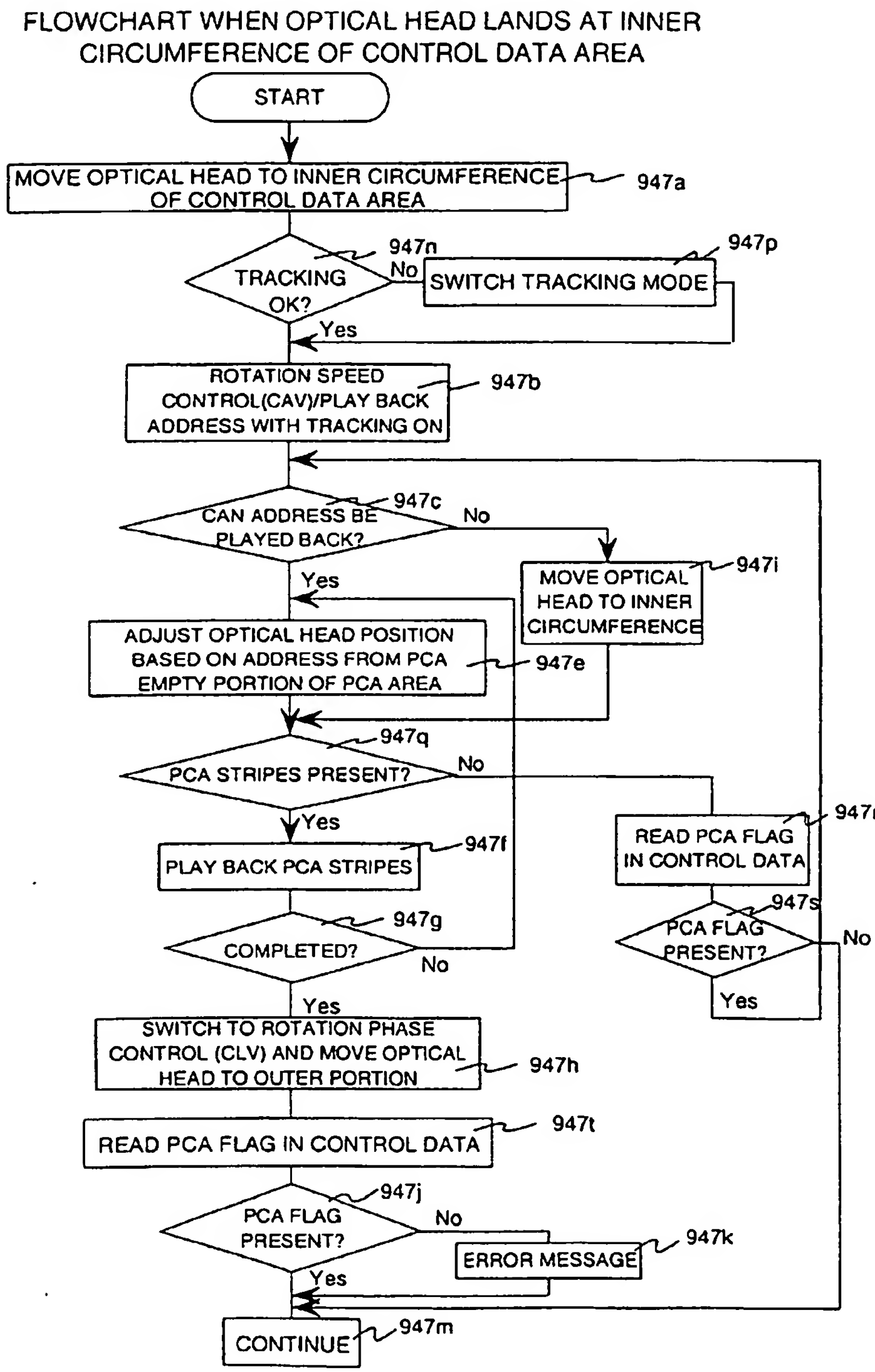

FLOWCHART WHEN OPTICAL HEAD LANDS AT INNER CIRCUMFERENCE OF CONTROL DATA AREA
START
MOVE OPTICAL HEAD TO INNER CIRCUMFERENCE OF CONTROL DATA AREA
947a
947n
TRACKING OK?
No
947p
SWITCH TRACKING MODE
Yes
ROTATION SPEED CONTROL(CAV)/PLAY BACK ADDRESS WITH TRACKING ON
947b
947c
CAN ADDRESS BE PLAYED BACK?
No
MOVE OPTICAL HEAD TO INNER CIRCUMFERENCE
947i
Yes
ADJUST OPTICAL HEAD POSITION BASED ON ADDRESS FROM PCA EMPTY PORTION OF PCA AREA
947e
947q
PCA STRIPES PRESENT?
No
Yes
READ PCA FLAG IN CONTROL DATA
947r
PLAY BACK PCA STRIPES
947f
947s
PCA FLAG PRESENT?
No
Yes
947g
COMPLETED?
No
Yes
SWITCH TO ROTATION PHASE CONTROL (CLV) AND MOVE OPTICAL HEAD TO OUTER PORTION
947h
READ PCA FLAG IN CONTROL DATA
947t
947j
PCA FLAG PRESENT?
No
ERROR MESSAGE
947k
Yes
CONTINUE
947m

Fig. 17

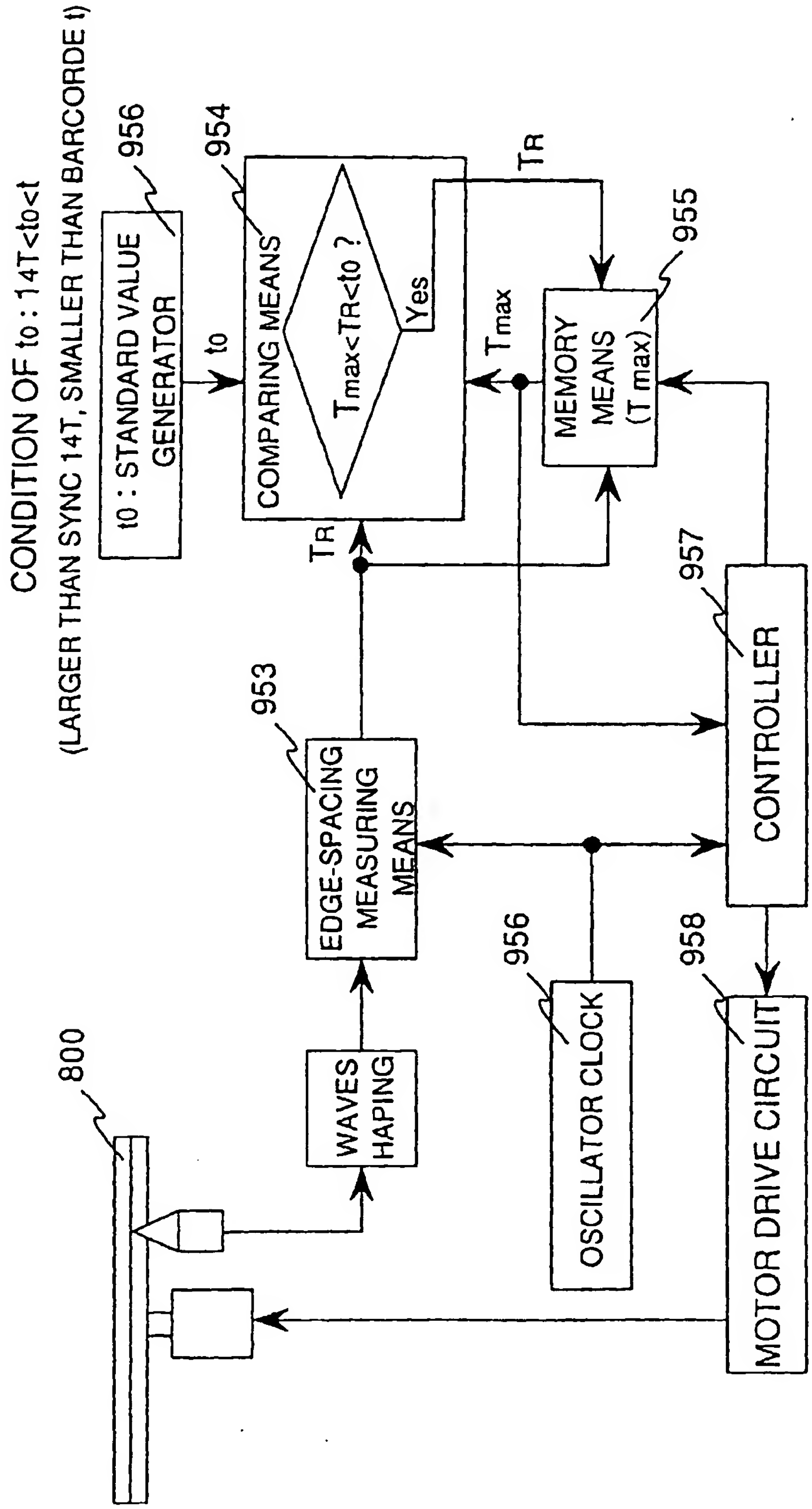

CONDITION OF t0 : 14T<t0<t
(LARGER THAN SYNC 14T, SMALLER THAN BARCORDE t)
t0 : STANDARD VALUE GENERATOR
956
t0
954
COMPARING MEANS
Tmax<TR<t0 ?
Yes
TR
Tmax
955
MEMORY MEANS (T max)
TR
953
EDGE-SPACING MEASURING MEANS
957
CONTROLLER
956
OSCILLATOR CLOCK
958
MOTOR DRIVE CIRCUIT
WAVES HAPING
800

Fig. 18

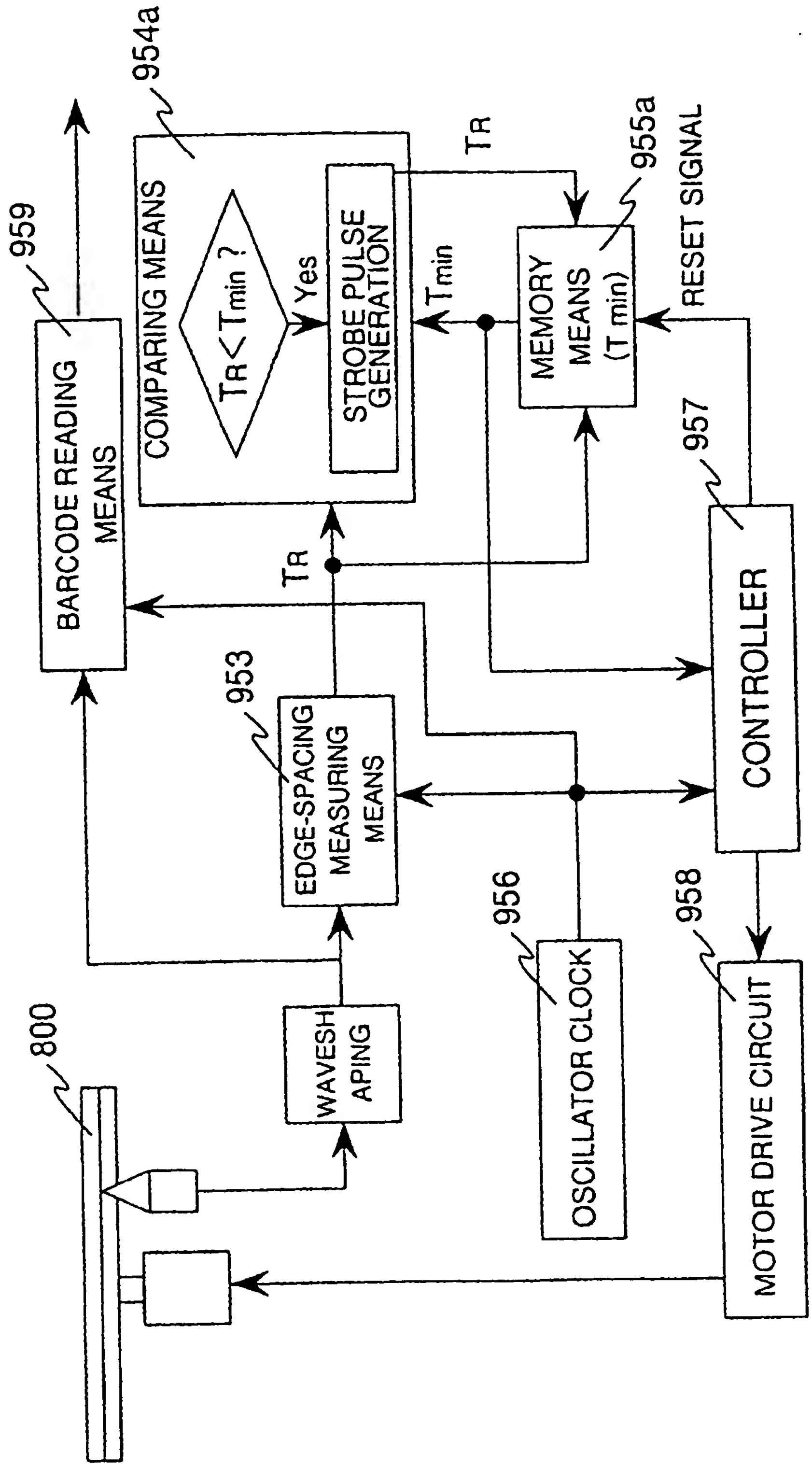
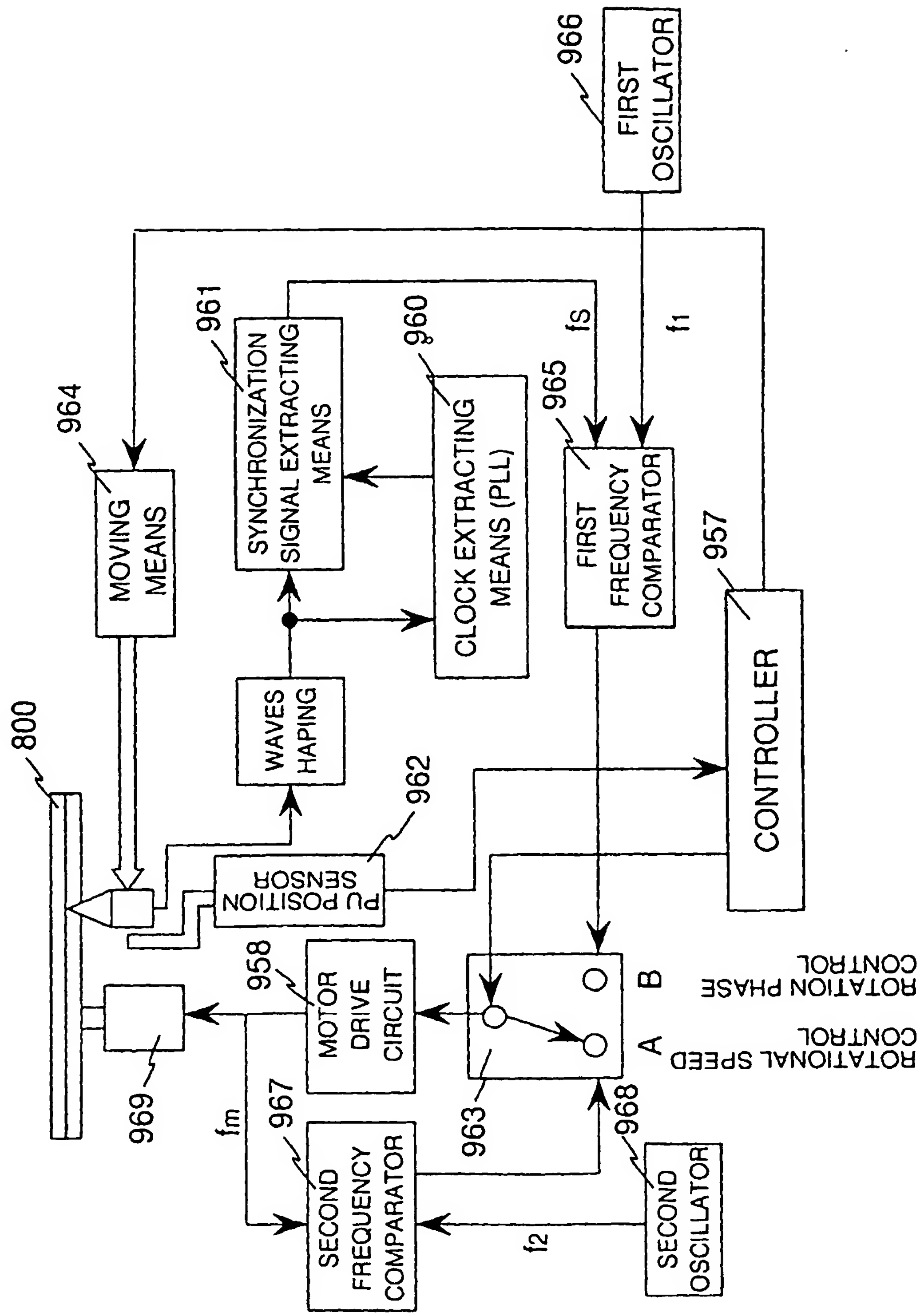

954a
959
BARCODE READING MEANS
COMPARING MEANS
TR < Tmin ?
Yes
STROBE PULSE GENERATION
TR
955a
RESET SIGNAL
Tmin
MEMORY MEANS (T min)
957
TR
953
EDGE-SPACING MEASURING MEANS
CONTROLLER
800
WAVESH APING
956
OSCILLATOR CLOCK
958
MOTOR DRIVE CIRCUIT

FIG.19


800
964
MOVING MEANS
961
SYNCHRONIZATION SIGNAL EXTRACTING MEANS
960
CLOCK EXTRACTING MEANS (PLL)
965
FIRST FREQUENCY COMPARATOR
966
FIRST OSCILLATOR
fs
f1
957
CONTROLLER
WAVES HAPING
962
PU POSITION SENSOR
958
MOTOR DRIVE CIRCUIT
963
A
B
ROTATIONAL SPEED CONTROL
ROTATION PHASE CONTROL
969
fm
967
SECOND FREQUENCY COMPARATOR
968
SECOND OSCILLATOR
f2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 11 2310

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	US 4 677 604 A (SELBY III HOWARD W ET AL) 30 June 1987 (1987-06-30) ---		
A	NL 9 101 358 A (HOMER B V) 1 March 1993 (1993-03-01) ---		
A	EP 0 553 545 A (SEGA ENTERPRISES KK) 4 August 1993 (1993-08-04) ---		
A	DE 43 08 680 A (FUJITSU LTD) 28 October 1993 (1993-10-28) ---		
A	PATENT ABSTRACTS OF JAPAN vol. 016, no. 495 (P-1436), 14 October 1992 (1992-10-14) & JP 04 178967 A (DAINIPPON PRINTING CO LTD), 25 June 1992 (1992-06-25) -----		TECHNICAL FIELDS SEARCHED (Int.Cl.7) G11B G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30 June 2000	Benfield, A

CATEGORY OF CITED DOCUMENTS

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